

IMPRESSIONS OF AMERICA

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BY

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ILLUSTRATED WITH DIAGRAMS AND STEREOSCOPIC VIEWS



London

C. ARTHUR PEARSON LIMITED

HENRIETTA STREET W.C.

1899



PREFACE



HOW this book came to be written, and the objects of the writer in publishing it, will be found at the end of the narrative itself: the author feels, however, that a few words on the subject of the illustrations, and more especially on the particular way in which the original photographs have been reproduced, are rendered almost necessary by the fact that many people scarcely understand the use of stereoscopic views, and very few indeed are aware that to use the pictures, no instrument besides the two eyes is absolutely necessary. First, then, as to the object of the pair of views which constitute each plate. A first sight these look exactly alike, but they are not so. Since the two eyes of a person looking at a view of any description are about three inches apart, he sees it differently with each eye: each eye has, in fact, its own point of view. How is it then, he may ask, that he is not conscious of the two different views? The answer is that in the

brain the two pictures are blended into one,—how, no one knows,—and the brain recognises the differences in the two pictures as what is called “relief” in the different objects it sees: they “stand out” solid, separate, and distinct from one another, in a degree unattainable by the use of one eye only: using both, we see them in “stereoscopic relief.”

To return to the illustrations in this book. The left-hand picture of every pair represents the particular view as seen by the left eye, and the other, the same view as seen by the right eye at the same time; and we have only to devise some means of seeing each view with the proper eye, and that eye only, to cause the observer to see the photographic representation of the view in all the original’s “relief.” It will no longer look flat, but the different distances of objects stretching away, one after another, into the distance, will be as clearly visible as they were to the author when he was taking the photograph. The result is that the picture becomes so much more “real” and intelligible, that the writer thinks it worth a considerable amount of trouble to acquire the power of seeing the views stereoscopically either by means of a stereoscope, such as is supplied with this book, or,—though in most cases it demands some little perseverance,—by the method to be presently described which needs no instrument, and which, when once learnt, cannot be forgotten and is perfectly easy.

To learn how to see the views in this book in stereoscopic relief without using a stereoscope:—

(1) Hold up the forefinger of your right hand in front of your nose, and about a foot away from it : fix the eyes, not on the finger, but on some object in front of you, but MUCH further off ; and while looking at the distant object, fix your *attention* on the finger, and close first one eye, and then the other, noting how the finger seems to change its position. Repeat this two or three times, and then open both eyes, still looking at the distant object, and still keeping your attention fixed upon the finger you will now see two fingers, one of them being caused by the right eye, the other by the left moreover, if you move the forefinger nearer to your nose, you will notice its two images move further apart, and, of course, if you move your forefinger further away from your nose, its two images will move nearer together. You must make quite certain of this step before going on to the next.

(2) Make a letter V with the fore and second fingers of the right hand, and hold them up as before, only rather further from your nose ; go through exactly the same performances as in (1) this time you will find that with both eyes open there are two images of the V seen, which together form a W, and if you consider the two middle strokes of this W, it will be evident that the left stroke is the image of the forefinger formed by the right eye, whilst the right stroke is the image of the second finger formed by the left eye : shutting first one eye and then the other will convince you at once of this. The important fact so far as we are concerned is, that these two images overlap, so that if we can

perform the same operations with two stereoscopic views instead of the two fingers, we can see two images of the views on the outside, corresponding to the two outer strokes of the W, here described ; and between them two overlapping views, corresponding to the two inner strokes of the W, one of which overlapping views is the image of the scene as viewed by the right eye when the photograph was taken, and the other is that of the same scene as viewed by the left eye : if, then, we can bring these two images into as exact coincidence as possible, we shall see the view in stereoscopic relief.

Turn back now to (1), *i.e.* the experiment with the forefinger alone, and keeping the attention fixed on the finger, look first at some object not very far behind the finger (*i.e.* on the side of it, away from the eye), and then at some object much further off : you will notice that the further off is the object at which you look, the greater is the distance between the two images of the finger, so that by looking at an object a suitable distance away, the two images of the forefinger may be made to move as far apart as we wish, within certain limits. It is in this way that we can bring the two stereoscopic pictures into coincidence, and although it is impossible to avoid a somewhat tedious *description* of this method, in *practice* it is *quite easy*, especially after a person has once succeeded.

(3) Look then at some distant object, and keeping the gaze fixed on it, move up into the position formerly occupied by the forefinger, the blank paper (Fig. A) with the dot in the middle :

just as before you saw two fingers, you will now see two dots. Of course as the paper is not transparent, it will hide the distant object from view; but a very little practice will enable you to keep the eyes exactly as they were when the distant object was in sight. Now do the same with Fig. B, with the two dots, and by a few trials choose *the distant object* at such a distance that the middle two images of the dots coincide: do exactly the same with Fig. C, looking first at the dots as you did last time, and when you have got the two middle images of the dots to coincide, transfer the *attention* to the cube above them, STILL KEEPING THE EYES AS WHEN LOOKING AT THE DISTANT OBJECT: YOU WILL NOW SEE THIS CUBE IN STEREOSCOPIC RELIEF.

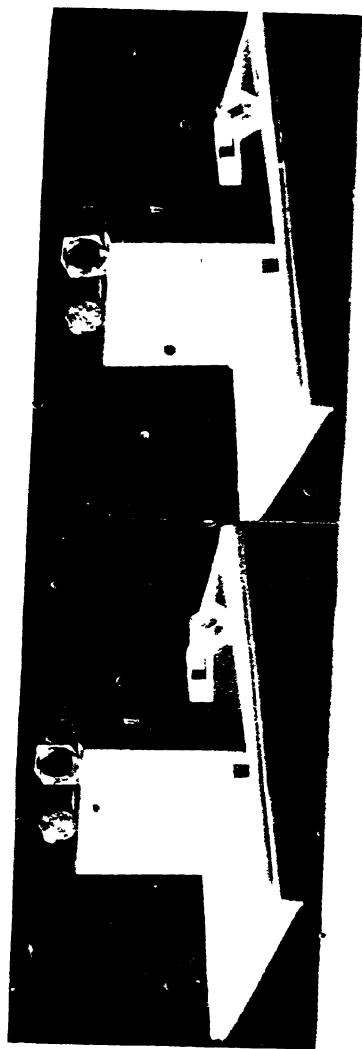
Lastly, take any of the stereoscopic plates—one with considerable contrast will probably prove easiest—and do exactly the same with it: the middle image of the three visible will be in stereoscopic relief, and the reader will probably think the result well worth the trouble he has taken. If he is still unsuccessful, he should make two dots with ink directly beneath the two representations of the same object in one of the pairs of views, and proceed exactly as in the case of the dots and cubes illustration. In the writer's opinion, if his eyes are not very abnormal, he cannot fail to succeed.

The two views should be held in a good light, and should be as equally illuminated as possible: the nearer the two dots or stereoscopic views are to each other, the easier it is to make the required coincidence; and if the reader finds himself

unable at first to bring about the coincidence of the two middle dots in the foregoing illustrations, he had better draw for himself two dots on a half sheet of notepaper, rather nearer together than those in the book, and try with these first, and then with others, a little further apart, until he can manage without difficulty those in the book. Some people will take much longer than others to acquire the power ; and it will be easiest for those whose eyes are by nature rather far apart : the wider the space between corresponding objects in the pair of stereoscopic pictures, the more difficult will they be, but in practice it appears that all the illustrations in this book can be viewed stereoscopically by the unaided eyes without difficulty, though some are a little harder than others.

If the stereoscope supplied is used, owing to the magnification given by all such instruments, the "grain" of the reproduced photograph becomes visible, which, of course, is to be regretted : in apology, the writer need only say that the very finest dotted screens have been employed of which the "half-tone" process is at present susceptible, and that any other process would have made the book very much more expensive. He feels, too, that the granularity, visible though it be, will not seriously interfere with the enjoyment he hopes this particular way of viewing the illustrations may give to his readers.

Those who already possess stereoscopes which cannot be well used for illustrations bound within covers, can easily cut the pictures out of the book,



and look at them with their instrument as they generally do.

The writer would like to add that the only book he has met with containing stereoscopic plates is one on the peak of Tenerife, by Professor Piazzzi Smythé. At the time this was published, however, no form of stereoscope could be made sufficiently cheap and portable to accompany the little book; had it been otherwise, no doubt the Astronomer Royal for Scotland would have adopted much the same course as the writer, who hopes that his effort to popularise this long-neglected instrument may not prove wholly unsuccessful. He would also take this opportunity of pointing out that those who possess magic lanterns can easily view their slides in stereoscopic relief on the screen, and therefore life size, if they wish, by printing the two views from the stereoscopic "negative" on one lantern plate (generally by reduction in the reducing camera), projecting the two views on the screen, so that the right eye's view is on the left, looking at the screen, and the left eye's view on the right, and then regarding them from a distance with the lines of sight of the two eyes crossed so that each eye sees its proper picture. The eyes can be made to converge to the right degree without effort, by looking at a finger, held about a foot from the nose, whilst the ATTENTION is fixed upon the views on the screen. Most people, in the writer's experience, are successful after very few trials, and are astonished at the result. The screen itself disappears, and the observer, if the picture before him be a landscape, sees it stretch-

ing away into the distance, the different objects in it looking so real that, did he not know them to be mere shadows, he would not doubt that he could walk into the scene, and further convince himself of their reality by touching them. .





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CHAPTER I



WE are close to New York at the time this simple story begins, after a voyage of six days—the first from Liverpool to Mizen Head, South Ireland, in calm weather, with smooth sea and cloudy sky. The outlines of Erin looked very grey and peaceful in the early morning light. At Queenstown entrance, three or four boats put out to meet us, and the fine-looking Irish women in them lost no chance of selling their laces and shawls whilst we waited for the overland mail. Soon the short, squat, sturdy-looking paddle-boat came alongside, and for about a quarter of an hour the crew swarmed like ants in a double line along the two gangways, carrying aboard their sackfuls of letters addressed to all quarters of the globe. When these came to an end, the bags and portmanteaux of the few passengers to be added to our list kept them busy for a few minutes, and then, with the gangway, the last link between ourselves and the Old World

was withdrawn, and we steamed away from the post-office boat, waving our final farewells.

It was Sunday morning, and though dull, and followed by a dull Monday, the sea was as smooth as could be wished. Our progress seemed to be generally about 470 to 490 sea miles in the twenty-four hours, and every night in the smoking-room a pool was formed by those who were ready to back their opinions as to the length of the day's run, often holding nearly £18. The tickets were sold by two spirited auctioneers, on one of whose cards I saw the interesting and rather ambitious titles—

“The Eastern Mystic
and
Prince of Orators.”

Several of the bidders, I believe, had little to bid with, but they did not seem to hesitate to give their ten or fifteen shillings with the rest.

On Tuesday night we struck the north-west edge of a cyclone; the wind was fairly strong from the north-east, but, as one could predict, it grew gradually weaker, and by Wednesday at noon had almost died away. It was fairly cold whilst this wind lasted, and damp too, with fine, drizzling rain. Then followed light north winds, and a gleam or two of sunshine, and by Thursday morning, off the banks of Newfoundland, we had entered the fog, which lay on the outskirts of the main mass of mist, in very long fingers pointing south. The water's colour changed two or three times in the course of the day from ultramarine to deep indigo, or the reverse: now

and then, however, it looked almost black when viewed perpendicularly, with scarcely a tinge of green, even in the foam.

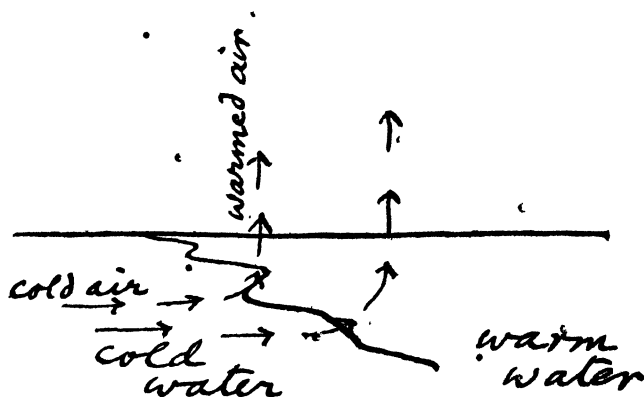
A whale had been sighted in the distance about three on Wednesday afternoon; two or three more were seen on Thursday, and one at least on Friday. They appeared just above the water, thus :—



or when they “spouted,” sent up a sudden squirt for some four or five feet into the air. This blowing lasted little more than a second, and their movements were far from easy to follow so far off. But though the whales were disappointing, the porpoises amused us much. Twice we saw small schools of them, swimming in column, two or three deep, and leaping out of the water beautifully, a rank at a time. Once we could follow them swimming beneath the surface obliquely towards the ship. They are friendly-looking things, very plump, with dark grey backs, yellowish-white beneath.* We saw no birds of any kind in Mid-Atlantic except two small ones, which seemed to accompany the ship—flying alongside by day, and, I suppose, resting in the

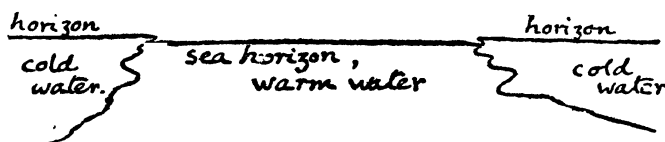
rigging by night. On Thursday I made the acquaintance of Mr. B., third officer, with whom I had a most interesting conversation, on the Gulf Stream. By throwing overboard at known spots bottles of clear glass, with instructions to the finder enclosed, and making a chart of their course, inferred from the places where they are found, the ocean currents are being unravelled slowly.¹

When the Gulf Stream meets cold air it forms a fog extending high over the warm water; on the other hand, when a cold stream meets warm air the fog is very superficial—only a few feet deep—and is called a “shaver.” Often there is a distinct line on the surface between the Gulf Stream and the colder water “as clean as could be cut with a knife”; and generally there will be a breeze along the surface of the cold water towards the warm which dies suddenly and completely when the warm current is reached. This is satisfactorily and easily explained in the same way as the “sea-breeze” is.



¹ See Appendix.

Again, a curious mirage is often noticed thus :—



This is easily explained by refraction of rays from points on and beyond the *real* horizon—upwards, over the warm water, and downwards over the cold.¹

The captain told me a yarn of a predecessor of his, a stern disciplinarian. One day when he was using the sextant, the sun was obscured by a small cloud at the very moment when it was required clear, and the mate, who was standing by watching his chief, said to him, "I'm afraid that cloud prevented you from making an observation." "It has not hindered *you* at all events," was the instant reply.

Our cabin was exceedingly comfortable, and the passage an exceptionally fast one, for the *Etruria* made her record run, and so we reached New York about eight o'clock on Saturday morning, and by nine had our luggage inspected—everything being opened—and drove off through strikingly handsome streets to the Murray Hill Hotel, using the time we had to stay in the city in visiting a bank and trying the elevated railway. It was a hot day, and the streets were very tiring.

What impressed me most at first sight was the height of the buildings, some of them twenty storeys and more; and also the absence of

¹ See Appendix.

smoke, perhaps mainly due to the season, as well as to the universal use of electricity. The steamer connection across the river is exceedingly good; every street of any importance ending on the river frontage has its busy little boat plying constantly between it and the opposite shore, so that the waters of the Hudson are very animated. No city that I have ever seen looked so busy, and at the same time so bright and clean. It gives you the idea of covering an immense area, and the long ride we took in one direction on an electric car strengthened this impression. The people look as if they worked hard, but had recreation too. Our stay was, of course, too short to get more than a rough idea. Brooklyn Bridge is magnificent, and the towers which bear the chains at either end are wonderfully light in structure, compared with any that I have seen in England.

That evening, as the train carried us swiftly along the broad, tranquil Hudson River, we passed through scenes of wonderful beauty:—bold rounded headlands of red rock, wooded from top to bottom, recalling Devonshire,—villages, towns, and country villas, nestling amid the trees, on the lower slopes,—yachts, with their white and brown sails perfectly reflected in the smooth waters—dreams of home scenery, like the Dart and the Tamar: a little later, and we plunged into the thick woods; but it rapidly grew dark, and time for dinner. Black waiters handed us dainty dishes and iced drinks. The cars are models of comfort, with smoking, dressing, and sleeping compartments, all brilliantly



Horse-Drawn Carriage, by Mr. C. H. H.

lit up by a gas which burnt with an unusually white flame, and gave an excellent light for reading.¹ Boys came round with papers and magazines, leaving several for examination, and were not at all grieved or surprised if on their return none were purchased. And so at last to bed : but although the berth seemed large after the ship's closer quarters, to sleep was not easy, for the pace of the train was very great, and the oscillations violent.

Next morning, about six, we passed through Buffalo, and with only the glimpse of a distant flash of white foam, which may or may not have been the Falls, steamed into Niagara station, and thence drove across the suspension bridge to the Canadian side, putting up at the Clifton, which has a superb view of both American and Horse-Shoe cataracts (Plate I.). Of these hundreds of descriptions have been written. Many I have read, and from them and from photographs of the Falls, and especially from the moving pictures, one may get a rough idea of what they are like. We learn that there are practically two distinct falls, with a full quarter-mile of island between them, and that the American is a few feet higher than the Canadian, or Horse-Shoe. Guide-books, in the style that is peculiar to them, tell you that the St. Lawrence is a mile wide at the place where it makes its great leap of 160 odd feet. Ruskin describes the rush of water at the rounded brink of the precipice as "sheer polished velocity," yet no descriptions I have read or heard from friends quite prepared me for what I saw. The American Fall is very *graceful*.

¹ Perhaps ethylene, or a mixture of coal gas and acetylene.

Doubtless the tall parallel furrows in the white foam make it look rather broader and not quite so high as it would seem without them.¹ It does not, however, produce any feeling of awe, even when the *Maid of the Mist*—as the little steamer is called—takes you close to the base, where the huge fallen rocks form a kind of rampart, through which the new foamy water rushes in milk-white streams. Viewed from the opposite side (Plate II.), this fall looks far less the work of Nature than many really artificial waterfalls I have seen—its lip is so straight and level. The water is a pale brownish-green only for the first six or eight feet down; it then becomes broken into spray, and remains snow-white for the rest of its descent. From its base long rolling clouds of mist are blown out over the water and rise, but soon melt into the air, and seldom ascend to the level of the brink. One cannot possibly criticise so calmly the vision which meets the eyes if they turn further to the west (see Plate I.), past the dry, ruddy face of the precipices beneath the dark trees of Goat Island. There, on the left, nearly a mile away, the sunshine kindles to transcendent whiteness a curved cliff of foam; and from just behind it bursts forth cloud after cloud of spray as though fired from a thousand guns, now rolling up billow on billow, now in countless spear-points of water turning at once to the finest mist—a mist which floats across the gorge, and rises broad and triumphant, decked with snow-white plumes and feather sprays, until, a mass of silver cloud, it drifts away across the

¹ Vide Appendix.



The American actor Nugent, from the Suspension Bridge, The Londoner, and the Londoner, on the left

summer sky. Just above this cloud of foam the great body of the river's water comes over in one massive, unbroken liquid wall of clearest emerald, fretted and flecked with falling crescents of foam, coruscating and scintillating in the sunshine. Here and there, on the arch of the water, flash, for an instant, drawn-out reflections of the sun like glittering threads of fire; but it is impossible for any one to put into words the look of irresistible power, of overwhelming strength, and crushing weight of that translucent mass of crystal. The *Maid of the Mist* ventures not near where the mighty river crashes into the waters below, lest the return current—swift and strong—should sweep her to instant destruction. The thunder of the conflict shakes the land for a long distance round,¹ and for three hundred feet or more from the bottom of this fall, the broad surface of the river is one seething and hissing mass of foam, tossed with waves hurrying from side to side.

On our first day we drove to the most interesting spots on the American side, and explored them all rather hastily. The Terrapin tower no longer stands on the rock at the edge of the Horse-Shoe Fall (Plate III.); they say that people persisted in climbing it and getting into danger, so that it was judged best to consign it to the mercies of dynamite, and thus it met its fate and went over the falls many years before it would naturally have

¹ At night we felt it quite distinctly in Clifton House—rattling loose windows. It is wonderful to think that this goes on *always*.

perished — for sooner or later this is what happens to everything near the brink. Looking down into the shallow border of the river near the lip of the American fall, one can see how the rocks disintegrate. Cracks at first very narrow slowly widen every year, until the loosened slabs are suddenly torn asunder and whirled away to join what is left of their former neighbours at the bottom of the abyss, where they are first shattered and then ground to powder.

Clad in tarpaulin, and looking like seals and penguins, we descended to the path cut in the rock, which leads behind the first few ribs of the western part of the Horse-Shoe, and were duly drenched in the fringe of the fall. I found the temperature of the *air and water mixed, and falling* in torrents of drops on the thermometer held at arm's length and drenched for three or four minutes, was 21° C. exactly; *the same* was the temperature of the *air full of fine mist* outside the thick spray and at the level of the water flowing away from the fall; whilst the actual *stream of water flowing from the base of the same torrent of spray* was at 22.3° C. at least, and may have been as much as 22.5° C., but stooping down to read the instrument immersed beneath the broken stream, with blasts of wind driving thick spray into eyes and mouth, so that one could scarcely breathe, it was not easy to make sure of the decimal as the scale marked whole degrees. I feel certain, however, that the reading was within the limits I have stated, and if so it is rather strange that there should be 1.3° C. difference between the spray, which after



The Brind of the Horse Show Fall Nagaia, from Great Island

falling makes the stream, only two or three feet above the water's surface, and the stream itself.¹ All was in the shade, though a brilliant sun was shining above the fall.

• We watched logs of wood, which had come over the falls, quietly stand on end and disappear in the vortex of the whirlpool, not to see daylight again for four miles down stream. We admired the wonderful Whirlpool rapids with their raging waves. I photographed the wildest spot of all—where Captain Webb was seen for the last time (Plate IV.). A man in a padded tub made the descent from the foot of the American fall to the shore of the Whirlpool, on which by good luck he stranded, in fourteen minutes; on opening the tub he was found more dead than alive, but he recovered. One other, the captain of a former *Maid of the Mist*, navigated this terrible stream in safety. He had fallen into debt, and was warned that the bailiffs were coming for him. For love of his *Maid*, and resolved that she should never be taken from him to pay his debts, he determined to risk his own life with his boat's, and turned her head down stream. Together they encountered the thousand rock-demons of that mile of wild surf, and, after some madly exciting moments, sailed safe and sound into the calm, free waters of British Ontario.

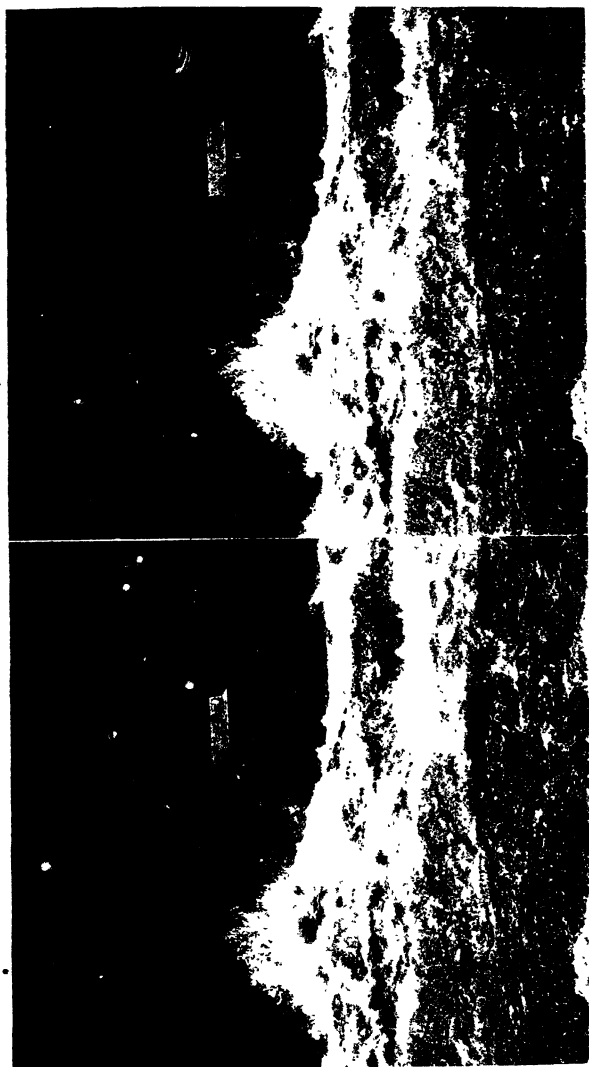
I visited the strange "Sulphur Spring" above the falls, where, in a space boarded round, gas comes rushing up through the black waters of a small pool, making them seem to boil violently.

¹ Vide Appendix.

The unlit gas contains sulphuretted hydrogen—of that there is no doubt. When a light is applied it catches fire with a burst of flame, reddish-yellow near the base, and in the central part, bright, like the flame of coal gas.

There was but little smell of sulphur dioxide, and from this fact, as well as from the appearance of the flame and its spectrum, it seemed to be *mainly* methane—or perhaps a mixture of methane, ethane, and other hydrocarbons. The spectrum ~~was~~ rather curious—I only made a very rough observation with a small pocket spectroscope; it showed on a fairly bright continuous band an intense sodium line (I suppose it *was* sodium, though my instrument was too feeble to show the line double), also a dull reddish orange line, so faint as to look almost brown, situated on the less refrangible side of the sodium, and a fairly bright line in the green which seemed well defined on both sides, and therefore could only doubtfully be assigned to carbon. So “Sulphur Spring” is only, as Tweedledee would say, what the spring is *called*. What it *is* I cannot say exactly, but it certainly is not chiefly either sulphur or compounds of that element.¹

¹ The spring might be *very easily* imitated, by laying on a copious supply of *unpurified* coal gas, and letting it bubble up freely through very dirty water; by dissolving salts in the water it would be quite easy to produce a spectrum rather different from that of coal gas. In the actual spring, although a considerable quantity of the gas escaped into the air before being lit, I did not notice any odour like that of ordinary coal gas; still the sulphuretted hydrogen would mask, to a considerable extent, any other smell. There might well be some *gold* in such a spring, if the price of admission were as high as the payment to see this “Sulphur” specimen!



Part of the Whirlpool Rapids in the Gorge below Niagara Fall where Capt. W. W. Wood was killed.

The Dufferin Isles are lovely, and the rapids above the falls well worth visiting. The river is so wide, that as one looks up stream and sees the long lines of tumbling, broken water hurrying to take their last leap, it resembles sea rather than river, and the cascades of snow-white foam against a dark sky make a beautiful picture.

Strikingly grand as Niagara is under bright sunshine, it is still more impressive at sunset and by moonlight. To take the evening of Tuesday, August 10th, for instance, we were then looking at the American fall from the west. Near the horizon lay a bank of heavy cumulus thunderclouds glowing in the orange and scarlet of sunset against a sky of pale saffron, piled up one above another, like range upon range of very lofty rounded snow-peaks. Filmey, salmon-coloured stratus, in long level lines, cut the upper slopes of these cloud mountains; whilst below them, and nearer, lay another range of weird dark purple clouds, contrasting wonderfully with the gorgeous hues of the distant giant range. Sharp against the inky horizon leapt and tumbled the amber breakers of the rapids, flanked with deep warm green of foliage on Luna and Goat Islands, the smoother patches of water reflecting the pale blue of the sky nearer the zenith. The tresses of the fall itself were all palest cream, losing themselves in the glowing heart of the half transparent foam wreaths¹ slowly curling up from depths already growing dark in the shadow of the

¹ This wonderful glow in the mist of the Horse-Shoe Fall is the effect of the reflection of brilliant sunshine from the smooth falling water on the spray.

cliffs. And who shall describe the wonders of the Horse-Shoe Fall at this solemn hour? Who shall paint the subtle shades of the huge pillar of rosy mist¹ ever rising to the sky, or the magic of the clean-cut sheets of emerald descending close beside this hazy, opal tower? The day dies fast,—fleeting is the glow of sunset, higher and higher climb the cold blue shades of coming night, brighter and brighter shines its gentle queen as she rises in matchless tranquillity over the far-away storm clouds, and Niagara, the sleepless, is meanwhile transfigured from one glory to another.

That night, about eleven o'clock, from Table Rock, which juts out over the waters, I saw the Horse-Shoe Fall by the brilliant full moon, which then stood over the rapids above the cataract, so that the part of the water about the centre of the great curve was in shadow, whilst to right and left the light fell obliquely on the waters in their descent. Palest grey are they, except just where they curve over; there, furrowed streaks of molten silver form the highest lights in all the picture. For a while the edges of the pillar of cloud lightly veil the moon, deepening the ghosly shadows, and the mystery of the depth below. Only the thunder of the falling waters, even louder now than by day, betray that they are real, so visionary and ethereal do they look. Dark and impenetrable, the serrated woods on either shore guard the boundaries of the endless race of eager waters, and over all the stars are glittering, set in the high arch of night. So has the Indian

¹ A rose-salmon colour next the sun, changing into pale cobalt through all the mixtures of cobalt and light red.

looked upon it from afar in ages past, scarce daring to approach the home of the Dread Spirit of the Falls; and so in ages yet to come, shall all to whom Niagara unfolds her wondrous visions, know that here the veil between the visible and invisible grows thin; they shall hear the voice of the Great Spirit in the sound of many waters, and see—if it be but the hem of his garment—in the whiteness which no fuller on earth can whiten.

The view from the top of the tower of the lift on the American side is good, and shows a little of Lakes Erie and Ontario; only part of the Horse-Shoe is visible, but the gorge lies open just below you as far as the Whirlpool.





CHAPTER II



NEXT day, Wednesday, August 11th, we said farewell to Niagara after a very fine glimpse of the falls from the railway to Chicago. Of that city we saw very little in the short drive from station to station; it has the same tall buildings as New York. We caught a glimpse of Lake Michigan just before reaching Chicago, and as we ran along its southern shore the waves were breaking on the beach under the sunset sky, in a northerly breeze, like the waves of an ocean.

On Thursday morning we reached St. Paul—after travelling through scenery something like the tamest of English landscapes—and left again by the Northern Pacific in the afternoon. The dust was a nuisance for the first time, and the dining car intolerably hot, as the windows had to be closed to prevent the dust from getting in. This plague of the desert is almost palpable—not gritty, more like mould. All day the clouds have been one stately procession of heavy cumulus, (Plate V.) floating in a bright blue sky, but different

from any I have seen in the prevailing shape which is columnar, getting thicker at the top, like the stumps of pollard willows, or like elongated broccoli flowers.

About 2 a.m. one of the grease boxes, which keep the axles of the car-wheels cool, got very hot and emitted volumes of dense black smoke; we had to stop several times before the remedies were successful. Meantime a severe thunder-storm was in progress. I watched it for over an hour; the lightning was, at first, white, and later on, yellow; the thunder, of the single-explosion type—not sounding like heavy boxes pitched down a long, carpetless, wooden staircase, still less of a boom and rumble, and also different from the hollow roar I have often noticed on semi-tropical sea-coasts. Over and over again there would be two loud cracks of thunder with an interval of, say, thirty seconds between them, *but not a glimmer of lightning visible*¹; then would come a blinding flash and an explosion about a second afterwards. Then a longish interval, with perhaps another flash and its peal, and then two peals again unaccompanied by lightning. Occasionally, very faint discharges occurred just before the brilliant flashes, suggesting the preparation of a way for them. This was, at last, followed by very heavy rain and wind. For a long while there had been scarcely any—only a few pattering drops falling. We had already crossed the Mississippi, laden with timber, at Minneapolis; and now, about six or seven in the morning, the

¹ The night was very dark, in spite of the nearly full moon, and I should certainly have noticed even a faint flash.

Missouri lay beneath us, a very wide, dirty-yellow river with mud banks. After breakfast nothing met the eye but undulating country, with toy hills and tiny watercourses marked green with rushes and shrubs. Short grass, brown and burnt-looking, covered it, mixed with a herb resembling lavender. Here and there small wooden huts or houses, with a few horses, cattle, and sheep scattered round them, marked a farm; but for the most part it was barren and lifeless. Nevertheless, in the clear, fresh morning air, the dust, fortunately for us, having been laid by the night's storms, the wide plains had a certain wild beauty of their own. The hills were flat-topped, most of them, and the sides of some of the streams suggested cañons already.

In the afternoon the "bad land" of North Dakota was flitting by the windows on either side—land which looked like the refuse-heaps of alkali works poured out in mounds ten to fifty feet high, and then worn into ruts by the rain (Plate V.). The hills were all horizontally traversed, as we saw them running from east to west, by rather widely separated layers of some harder black material, only an inch or two thick. It was here that the Indians gave trouble about five or six years ago, so one of the blacks said. The wind was north, and this, with some storm showers, cooled the air, and made travelling delightful in the "annex."

Some of the low cones recalled very forcibly the Red Coolins of Skye, but, although like the Coolins in colour and shape, they cannot be worn-down volcanoes, for the very long lines of strata, all inclined at the same gentle angle east and



west, and more steeply in sections lying north and south, prove their watery birth. Although built of a soft material, which seemed to the eye a kind of sandstone, their sides are very steep; and this, as well as the depth to which even the small rills cut themselves channels, indicate that although this soil is too hard for the raindrops to wash down, it is too soft to withstand the action of the streams of water formed after the rain reaches the surface. There was a beautiful sunset, the shadow of the earth rising in the eastern sky so well marked, that had I noticed the time it took to reach the zenith, it might have served for a rough determination of the least height to which the atmosphere exists.¹

Several prairie dogs we saw, some sitting up like squirrels or kangaroos, and eating; others squatting low; they took very little notice of the train. Gradually the valley of the Yellowstone, up which we are now travelling, becomes more fertile, large fields of rather stunted Indian corn and thick copses alternating with tracts of desert which grows only short, coarse grass, the lavender-like shrub, and very dwarf cacti with bristles. The prairie dogs and their mounds, like large mole-hills, only appear where the lavender shrub is wanting. Tiny sunflowers there were in great numbers, with dark eyes and long, thin stalks; a small pinkish-violet thistle cropped up now and then, and a white flower in patches. The full moon rose soon after sunset, and it grew much colder. Next morning the aneroid

¹ Some similar observations made later gave from 150 to 180 miles.

barometer marked 4,100 feet at Livingstone, so that we had gone up some 900 feet in the night. The lower part of the valley of the Yellowstone, along which the railway runs, is about 3,200 feet above sea-level for miles and miles.

Friday night was only remarkable for the occasional violent charges of the engine against the carriages—I suppose after being detached to take water, or perhaps exchanged for a fresh engine. Once I was within an ace of making a sudden and unpremeditated aerial descent from my upper berth, but wide awake in a moment, I saved both person and appearances by instantly clinging like a bat to the sideboard.

Saturday morning broke brilliantly as usual, and it was baking hot on the box seat of the coach and six that plodded along the road to Cinnabar. Soon after "Emigrant" we passed on the right a very fine dyke, and an eagle's nest, with one bird near it, high up on a sort of earth pillar to the left of the road. There were several frail plank bridges, whose strength we must have tested pretty well in crossing. If it had not been for the firs, aspens and willows, sunflowers, dwarf cacti, poppies, and other flowers we could call by no specific name, one narrow gorge might have been Norwegian, or even in North Wales; but the hills above us all the way were bare except for the pale bluish-green sage bushes, and the ashy soil is of so strange a colour that it almost matches them.

The scenery, in great part, brought Pedro Gil, in Teneriffe, vividly to mind, for the hills looked burnt up and arid to the last degree. The

Devil's Slide is a magnificent pair of parallel dykes, both tipped over towards the east, and running the whole way down the face of one of the lower spurs, with a smooth—perhaps water-worn—channel between them, vermilion in the centre and yellow ochre at the sides.

After dinner at the Mammoth Springs Hotel, we went to see the terraces of carbonate of lime, deposited by the hot waters in their course from the boiling springs down the hill-side; and wonderful they are, both in form and colour—veined marble staircases, a turquoise pool in every step. I descended into the Devil's Kitchen by a nearly vertical ladder, the rungs of which are a trifle worn. It is a narrow tilted shaft, wider below, and entirely coated within with the limestone deposit. The Angel's Terrace was next inspected and photographed. By the side of one large pond of warm water, often used for bathing, and surrounded by woods, two snipe were wading. H. actually got within six feet of one of them; they both seemed quite tame, and paddled about unconcerned whilst we watched them. No one is allowed to molest the animals in the park; the penalty for breaking the protective laws is severe—for instance, a man was fined 100 dollars with six months' imprisonment for shooting an elk. The pretty little chipman squirrel, shy enough in most places, showed no signs of uneasiness when we came almost near enough to touch it, and continued busily eating fir-cones as big as itself.

The Mammoth Springs Hotel is built over two great caves, the main entrances to which are down

by the river three or four hundred yards off ; but through some loose planks there is another opening just outside the house. At the present time there are many wild beasts in these caves. They only come out after nightfall, and though they are often seen sneaking round in quest of scraps of food, they have never as yet harmed the poultry, and seem to prefer hunting in the woods. Amongst them are the polecats and coyotes, a kind of wolf-dog. I asked if the polecats smelt much. The man turned away his head with an expressive "Teugh!" which spoke volumes. There are plenty of black bears near ; they do not, however, attack men, nor do men attack them in this region of peace. One evening this summer a she-bear and her young one visited a hotel not far away^f; the young one came in and sniffed about, whilst the mother waited outside. After satisfying its curiosity the little bear walked out again, and they went quietly away together. It is not the beasts that are to be feared so much as men ! This very morning, eight of the ordinary coaches conveying tourists were "held up" by two rascals masked with sacks pierced for eye-holes, their feet padded to prevent their leaving a trail, and armed with Winchester rifles and revolvers. These two made the men, about twenty in number, stand in a row with their hands up, and, covering each in turn, forced them to part with their money, thus collecting about 300 dollars. They are thought to be young hands at the business, as they did not cut the wires connecting the various coaching stations, and so in a very short time every one in the district heard

what had been done; soldiers were sent for at once, and arrived at about the same time that we did; but in spite of all this, the general opinion seems to be that the men will not be caught.¹ They treated the ladies civilly, asking them whether they had any money, and taking their word for it if they replied "No," as one or two did. They did not *search* any one; and at this moment a tourist is boasting that he got off with a loss of only ten dollars, whilst over two hundred were in his coat pocket. It is supposed that one of the robbers is a murderer who has been "wanted" for some time, and that either failure of provisions, which seems scarcely likely, or want of funds to leave the country, was the cause of the attack. It is some years since the last raid of the kind was made, and the event keeps a great many tongues busy this evening. One lady is said to have burst into tears on hearing of the adventure of the "holding-up" party, so annoyed was she at having missed the excitement!

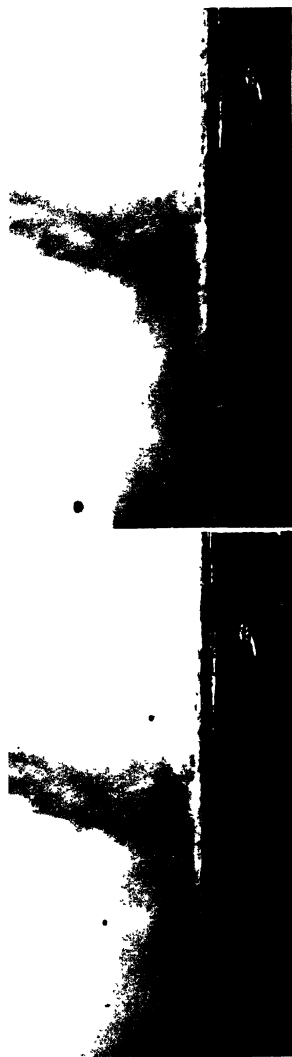
Day broke with another cloudless morning, and the air delightfully cool and fresh. With a pair of capital horses, and relieved of our heavier baggage, we started for the Norris, or Lower Geyser Basin, which proved every bit as good as the guide-books made out—the "Monarch," however would not play, and military police and the lack of a box of soap rightly prevented any of the more reckless spirits from hurrying his operations. This way of precipitating an eruption was discovered by a luckless Chinee, who, thinking that

¹ Just before leaving America, it was rumoured that the efforts of the police had proved successful.

much trouble might be saved in washing his clothes by the use of a quiet-looking geyser pool, proceeded to carry the thought into action ; when suddenly his clothes and several tons of water were ejected together, and the share he received, proved both hotter and heavier than he could bear, and he was killed on the spot.

The roaring steam geyser, "Black Growler," in the Norris Basin, is now depositing a gelatinous pure magnesium silicate ; my guide tells me that this kind of deposit has only been forming during the last two years. Two cases I saw, passing strange, of a large geyser pool of boiling water beautifully clear, and within a yard in one case and only a foot and a half in the other lay a much smaller pool, also of boiling water, but full of precipitated sulphur, a mixture of the consistency of very thin mud. It is difficult to explain the entirely different character of springs so very close together. One thing seems certain, their supply pipes cannot have any connection. The "New Crater" geyser is very fine ; it came into existence about two years ago, with earthquakes and phenomena resembling a true and explosive volcanic eruption. A double crater was formed, large stones being ejected, and now a geyser plays from either one or the other, but never from both together.

After waiting a short time by the "Monarch" in vain, we set off again in our cosy little car, and passed rapidly through some lovely pine forests, first by Gibbon river, and down the Gibbon cañon with its pretty fall, and then by Fire-Hole river, which teems with good fish. Sometimes



The Little Lighthouse, Cape Cod, in twilight, evening light

we drove by boiling springs quite near the road —Beryl spring for instance : at others we could see only the steam rising amongst the trees. Two cold springs of mineral water we tasted ; one, the Apollinaris, bubbling with carbonic acid gas, the other strongly impregnated with iron and soda, tasting like ink. We heard, on our arrival at the Upper Basin, that the Smaller Fountain geyser was due to play, and I hastened to the spot, camera in hand, and found a good many people, some standing, some sitting, waiting for the troubling of the clear waters of the pool, which lies on the top of a broad, gently-sloping, dazzling white terrace of silica.¹ Presently, the appearance of a small jet, like that of a fire-plug, gave us warning, and caused a sudden retreat of the spectators from the basin, and then up sprang a thick column of water, about twelve feet high, whilst the spray flew thirty or forty feet, and the dense cloud of steam rose two or three hundred feet higher into the air (Plate VI.). Suddenly the wind shifted, and the descending shower of hot spray drenched one of the spectators in a moment, but did not hurt him much ; the others applauded vigorously, whilst the victim himself retreated as fast as he could from that side of the basin.

After dinner, we went to see the wild bears come down to take the pickings the hotel people put down for them on the outskirts of the wood to the north of the hotel, and about four hundred paces from it. We had not long to wait. Scarcely had the cart carrying the refuse, and drawn by two

¹ The substance of which sand is chiefly composed. Pure silica is found crystallised as quartz

horses, deposited its load, when a large black bear shuffled lazily out of the forest, easy to see, as he crossed a white geyserite patch, and began his meal about a hundred paces from the hotel visitors. We watched him a long time ; I hoped to see more, but no others appeared then, probably because of the loud talking and laughter of some of the people. The bears often come in large numbers, seven or eight quite commonly, and sometimes they actually try to climb up into the cart. Although horses as a rule are rendered almost mad with fright by a bear, or the scent of one, those that drew this cart are quite accustomed to their visitors, and take no notice of them whatever. It is a strange sight to see. A. old backwoodsman, who knew Yellowstone some years before any of the hotels were built, and who had fought in no less than eighteen battles, told me that his experience was that " If you act fair by bears, the bears will act fair by you " :—and so with most animals, but not with all—not with the mountain lion !

Last evening, on returning from an intensely hot and very active day in the Upper Basin, I had no time or inclination to do more than change my plates—a desperate performance when tired out, and with nothing better than a pair of steps to change them on. The consequence is, it is difficult, even at one day's interval, to give any adequate account of that home of geysers. Perhaps the most lovely things of all we saw were " Morning Glory " and, late in the afternoon, the Emerald Pool. They are both indescribably beautiful, and one could easily imagine be-

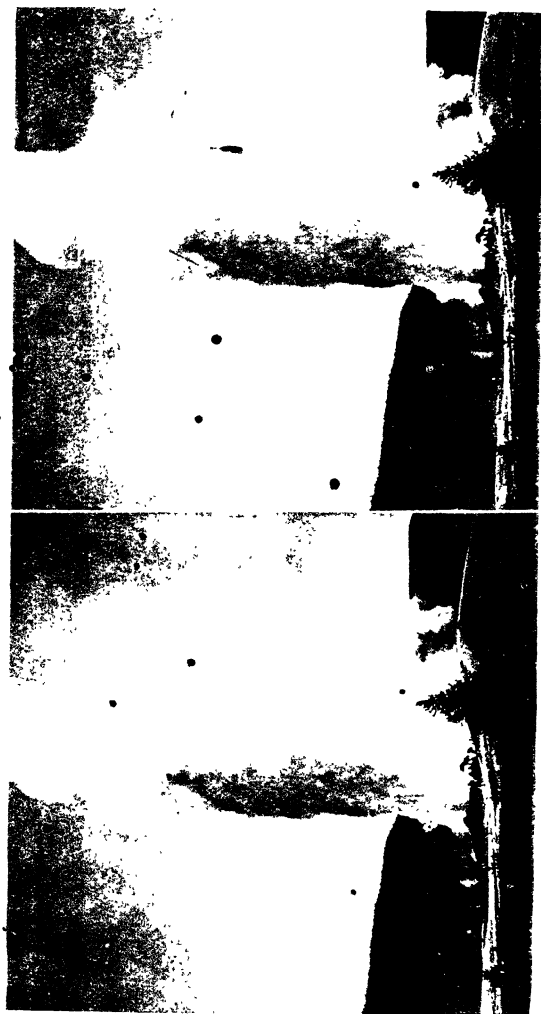


Figure 1. Old Fort. Upper left: River. Yellow tone. Pink, from the West, morning light.

coming so enchanted with those clear crystal depths as to draw nearer and nearer, till with a fatal plunge all is ended—for in a few minutes, so they say, a man's flesh boils to rags. In a horrible example, which one hopes may be wholly untrue, but which was nevertheless mentioned as a fact, a man was trying to sound the depth of one of these azure pools, when the crust under foot gave way; before any adequate help could be given, a period of three to five minutes according to the story, he was hopelessly boiled, and only his skeleton took the hook with which they fished for his remains!

The first great sight on the way to the Upper Basin is "Excelsior," the water volcano: the throat lies concealed in a boiling lake about three hundred feet square. Its eruptions, which are very rare, are simply appalling, the explosions shaking the whole region. The water flows from the lake into Fire-Hole river, down a tetrace streaked with the most gorgeous yellow, orange, pink, brown and mauve tints. Near it is Sunset Lake, a broad sheet of hot water, with exquisite scalloped border, and lovely rippling shallows. The Grotto geyser was on the point of playing as we approached it. I photographed it before the eruption began. Soon after a grand burst of steam and a soaring column of spray told us that the "Splendid" was playing; we were very lucky to see it, as it often has long and uncertain periods of rest. The water flew two hundred feet into the air, but before I could get my camera ready the spectacle was over; and though the geyser played in the distance two hours after-

wards, and again two hours after that, and looked as though a fourth outburst were imminent, when we passed close by its basin in the afternoon, I did not get a chance of taking it again. The "Giant," with a crater like the rent stump of a tree when seen from outside, was also preparing to exert his enormous strength and the three little "indicators" which rise beside him were fuming and spouting constantly; but he did not get above just boiling over now and then, so we drove to the lunch tent, and hearing that one of "Old Faithful's" exhibitions was to be given in a short time, left at once for a little plateau near him. Punctual to the minute, as he almost always is, a low, thick column of water rose from the white cone which crowns his beautiful terrace formation; then this subsided and rose again a little higher, again sank, and after a few seconds of breathless expectation, amidst dull sounding explosions of steam, there burst forth the great fountain (Plate VII.)—now and then sinking a little, and then soaring far above the rolling clouds of vapour, shining like silver in the bright sunshine (*vide* Plate VIII.), and falling in shower after shower of liquid diamonds, whilst the shallow basins below (*vide* Plate IX.) were swept with glittering flashes, as though watered with white fire. All the time, flickering rainbows burnt in the sheets and fringes of spray, and down the snow-white sculptured terrace-steps flowed innumerable little cascades of bubbling water, sparkling brightly. Gradually the fountain grew lower, until at last it disappeared. For a few minutes small domes of water would burst over the cone, and fall into the side basins;





Two views of Silver Lake, showing the pool of hot water on the S.W. slope of the cone of Old Faithful.

then even this ceased, and the great geyser fell asleep, to wake again after sixty-five minutes' rest.

Scarcely had I photographed this splendid sight, and turned to inspect the Cascade geyser, which was playing, when suddenly the "Castle" shot up a column of steam and water with a loud roar. This was unexpected, and we made our way down the slope to it as fast as we could, but not fast enough to get up to it before the best of its play was over. It was a beautiful sight, even from a distance, but the guides thought it a poor display for this particular geyser, which sometimes—according to them—sends aloft a spire of water nearly two hundred feet high for fifteen minutes, and then roars steam furiously for as long again.

After viewing the Castle from all sides we crossed the meadow—if that marshy tract can be so called—and the river by the rickety plank bridge, and met a boy who acted as guide to the geysers and pools on the east side of the stream. One of the "Lion's Cubs" was playing, but its parents both slept. I photographed the young one and its father; and then, passing the "Beehive," which, much to our regret, did not play and was not expected to, we examined one or two pools and the Cascade geyser, and then made our way back to "Old Faithful" to witness his next outburst (Plate X.) from the east side. It was magnificent, but a cloud came over the sun and did not clear till just before the close, so that I expect the photographs will be lacking in light and shade. When all was over, with another guide I walked past the Castle, taking a second glimpse at the wonderful formation which lines its

inner walls, and then waited a few minutes to see the small but perfectly regular "Economic." All its water flows back into its throat after it has played, and the eruptions occur every twelve minutes. One would naturally expect in cases like this, where the boiling water which has been ejected in one eruption, and is still very hot, forms the material for the next, that the period of repose would be a short one—as it is.

Strolling further to the riverside geyser, we witnessed a fine and long-lasting eruption. Its surroundings of wood and river make it more picturesque than many of the others, but it throws the jets of water and steam obliquely across the river, and the fountain is also oblique to the bank, an arrangement of lines which is not so satisfactory, in my opinion, as the perpendicular fountains. Here again the camera came into use. After some little debate, we settled next to see the "Emerald Pool," one of the loveliest imaginable; and then lingered some time by the "Splendid," which, as I have said, did not oblige us by repeating his morning performance. And so we turned homewards, past the Grotto geyser (Plate XI.) and gave a second look at the gigantic "Excelsior," the "Turquoise Spring," and "Sunset Lake"; and, in rather over an hour, saw the now familiar lights of the Fountain Hotel, where the evening quickly passed in dining, changing my photographic plates, and writing.

A trifle tired by our long days, we determined to make our next rather easier; so, soon after breakfast, but not quite so early as usual, we set out with our cheerful driver to the "Great

Figure 1. The effect of the concentration of the solution on the rate of the reaction.





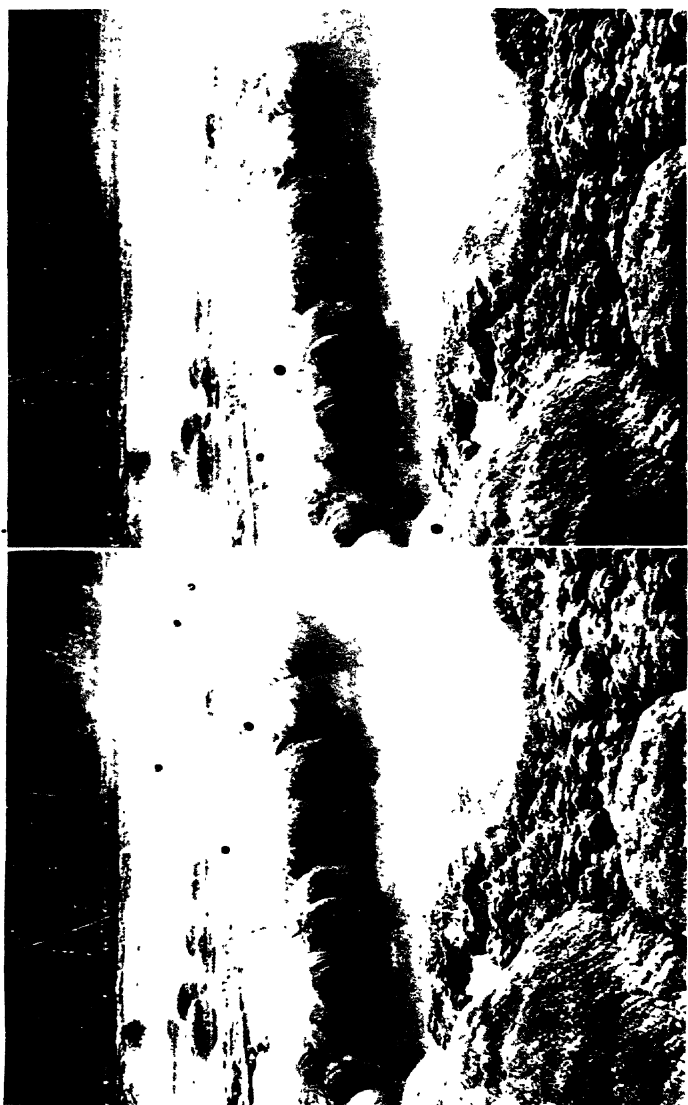
Fig. 1. Family of the author in the field.

Fountain," about a mile and a half through the woods, expecting it to play about 10 a.m. On arriving; it seemed unready, so we drove to Fire-hole Lake and inspected the extraordinary blue flames, which seem to rise in two places under the water. It was a showery morning, and an easy proof that the appearance is not due to flame was given when the sun suddenly flooded the dark lake with light. The mysterious flames became much brighter, whereas, if they had been self-luminous, they must certainly have faded to some extent. A second proof is, that they are barely visible by bright moonlight. No one has, so far as I could learn, attempted to see them in the dark; and no wonder, for the shore of the lake is a crust of geyserite which is very unsafe in places, not to mention the steam fog, which always covers the surface of the ground round these hot lakes at night.

Returning to the "Great Fountain," I had barely time, in the rain which was falling, to set up my camera, before its eruption began. Great masses of water were thrown up by successive explosions; and once, above a broad base of curling vapours, the boiling waters formed a splendid column—probably two hundred feet high—but it was only for an instant, and passed before I had made the exposure of the plate; afterwards, it played grandly, but never attained anything like this height, and the dull light was not at all favourable to a worthy representation of what I saw. Hoping to avoid the dense clouds of steam, which the uncertain wind was blowing now and then a great deal too near me

to be pleasant, I changed my position to the opposite side of the wide basin ; but by that time the geyser had apparently exhausted its powers, and, after photographing the lovely pool terraces round the opening, I walked across to inspect the water seething in the throat, on the assurance of the guide that all was safe. H. had already seen it and retired. Scarcely had I got up to the lip of the crater, when a renewed violent boiling and splashing made me retreat rather rapidly. I should have gone considerably faster but for a large man in front, who blocked the narrow path of planks in single file leading over the scalding pools, and seemed dazed by the sounds behind him. An explosion behind me made me run ; a vast mass of boiling water again shot into the air, but I had reached safety before the scalding shower descended. After this I shall not be so ready to believe the assurances of even the best guides. The geyser, in fact, had only accomplished half its programme, and played grandly in the now bright sunshine for several minutes more ; and it was not for several minutes after it had ceased for the second time, that I ventured to plant my camera on the lip of the crater, to get a view of the wonderfully beautiful incrustation with which it is lined (Plate XII.).

It was a frightfully hot day. About lunch time, whilst changing plates on the top of the steps as usual, and still suffering from a difference between the size of my dark slides and the plates, I heard thunder, rapidly growing louder with every peal. The " Little Fountain " was to play again about two o'clock, and the spectacle was rendered



finer than ever on the sunny side, by the contrast of the brilliantly illuminated drops with the inky sky behind them. Viewed from the other side of its large basin, by stooping down until one could see the sun through the spray, a very curious effect is produced by the shadows of the larger drops cast upon the steamy mist, and thus made visible in long, thin lines. These seem to radiate from the sun, and as the drops are falling, and their shadows lengthen as they get further from the centre, they produce an effect very much like a kind of catherine-wheel, with the sun in the middle. I do not remember ever reading of this, and it may be that no one has happened to notice it. Of course it is most easily observed when the sun is low.

After some very fine multiple flashes of lightning, all at a considerable distance, the storm passed away, and under a glare almost painful we strolled about looking at various pools and formations on the Fountain terrace. We were specially pleased with a large shallow pool, full of a seaweed-like growth, which stopped short at the surface of the water, so that the whole had the look of some marvellously handsome, highly polished section of an enormous tree-stump. The colours of this pool ran through all shades of amber to bright golden yellow, and so through rich siennas to the umbers, from the lightest to the darkest; whilst the glassy surface of the water, itself so still and spotless as to be invisible even on close inspection, reflected the azure of the sky, giving an indescribable softness to the blending tints. There were some very curious

spiders about, the size of our large garden variety, which moved very rapidly by leaping on the surface of the warm water. Their colour was blue-grey, they were hairless, and their legs rather long. They seemed to take a fancy to our boots, and, if the truth be told, they jumped so long and fast, that we had some difficulty, on this treacherous ground of pools and streams, in keeping them at a respectful distance.

Crossing the waggon trail above the terraces, we came to the mud volcanoes. They are well described in the books, and one need not say more than that the colour of the crater wall is a yellowish white, the thin, boiling mud inside being a pure light grey. These I photographed carefully (*vide* Plate XIII., which gives a general view of one of the mud volcanoes, which are called the Mammoth Paint-pots; and Plate XIV., which is an instantaneous photograph of a large bubble of mud blown by the steam, and taken in the very act of bursting).

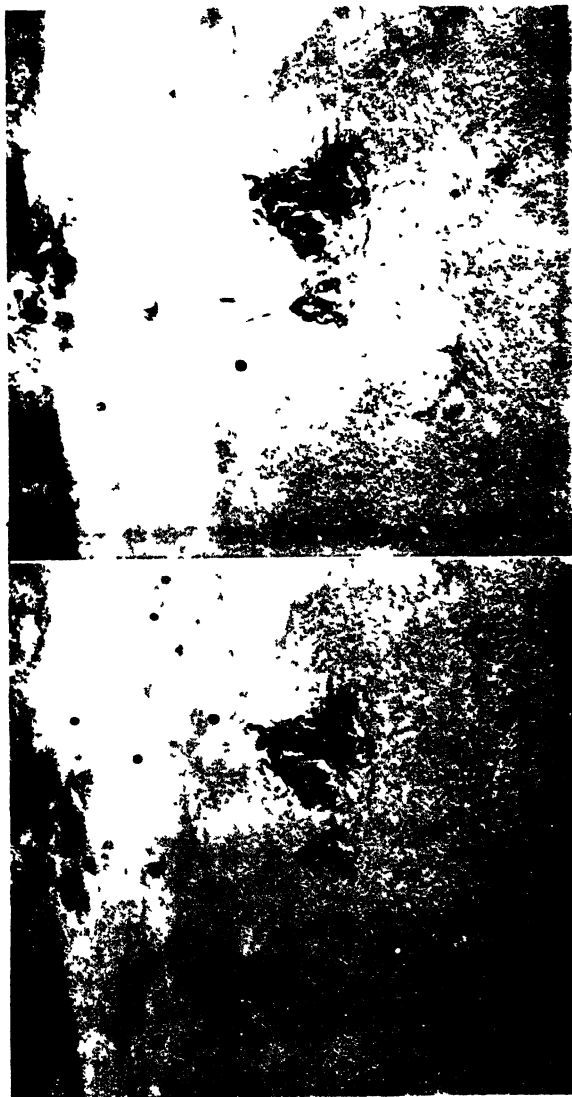
In the evening some niggers amused us with songs, accompanied by banjo and mandolin, and some very clever step-dancing. "Way down upon the Swanee River" is sung very slowly, and as a pathetic song—not at all as I have often heard it "rendered" in England.

Before dinner, we went into the wood at the back of the hotel to see, if we possibly could, something more of the wild bears, and to try to get some photographs of them. After sitting quietly for an hour under the trees on the edge of the wood, I suddenly heard twigs cracking, and the sound of some heavy animal moving



Mt. Carbon. The Mountain Point part of the section. In the background, a silty and a reddish
 clay and a very clayey and is light gray. The lower part of the section is a

The section of the Mountain Point



Part of the center of the Mud Column (Plate XIII) showing, (1) a steam mud bubble in the act of bursting, (2) other smaller bubbles in various stages of exposure (1/4 inch of 1 second) (1/4 inch of 1 second)

quickly close behind us. Standing up and looking round, I saw, through the tree trunks, a great big black bear coming straight towards us. At the same time he spied me, and instantly changed his course, crashing away back into the wood. We had all but given up hopes of seeing any more of them, when, behind a thin line of trees between us and some white geyserite, the same black bear reappeared, walking leisurely down (*vide* Plate XV.) to the refuse heap mentioned before. I secured two pictures of him before he spied us again and retreated, stopping every now and then and gazing hard in our direction. Just then the scrap cart came into view, with a pair of horses, and soon afterwards we again sighted our bear behind us in the wood; at least, we could see his head just over the undergrowth, eyeing us and the cart alternately. Then he moved slowly to the left, and made two or three visits to the food heap, evidently very shy, for he seized a piece or two, and hurriedly retreated to a retired spot to enjoy it, coming back again for more, two or three times.

Presently there came from the same part of the wood a very large she-bear, also black, and a fine cub; and then two other black bears. The mother clearly ruled the roast, and when either of the other two tried to get something to eat, she growled savagely, and half turning towards them, drove them from the tempting heap. After seeing that the cub was choosing morsels suitable to its years, she ceased eating, and gazed long and anxiously towards the spectators, of whom by this time there were a considerable number,

and at last retreated, driving her cub before her, evidently uneasy about it. Eventually she drove it up a tree, where it remained so long as we were there, whilst she herself went back to feed, the two other black bears prowling round, but not daring to eat so long as the she-bear was at table. I photographed the mother and cub as they were crossing the geyserite, alarmed chiefly, I believe, by the stand camera and its black cloth. We heard that later a large cinnamon-bear, of whom all the others stand in awe, came down from the woods to the feast, but we did not see him, and by that time it was too dark to make any more photography possible.

Next day we made a very early start—it is always cold here in the early mornings, and a great coat is a welcome addition to one's clothing. On the drive to the Upper Basin we saw a timber wolf which crossed the trail. He stayed a moment or two in the wood there, and then recrossed, gazing at us wistfully before vanishing again. They are very fierce beasts, harmless by day, and never attacking man singly. But at night, and when they have the courage numbers give, a man could not meet with a much more unpleasant foe. They leap at him, snapping at each bound, and biting out, cleanly, a mouthful at each snap. We also saw a large fox with a splendid brush, darker in colour than our English breed, larger, too, and stronger looking. As we passed through the Upper Basin, none of the geysers were playing, but the whole plain was steaming, and looked most extraordinary. Soon after losing sight of this wonderful tract, we

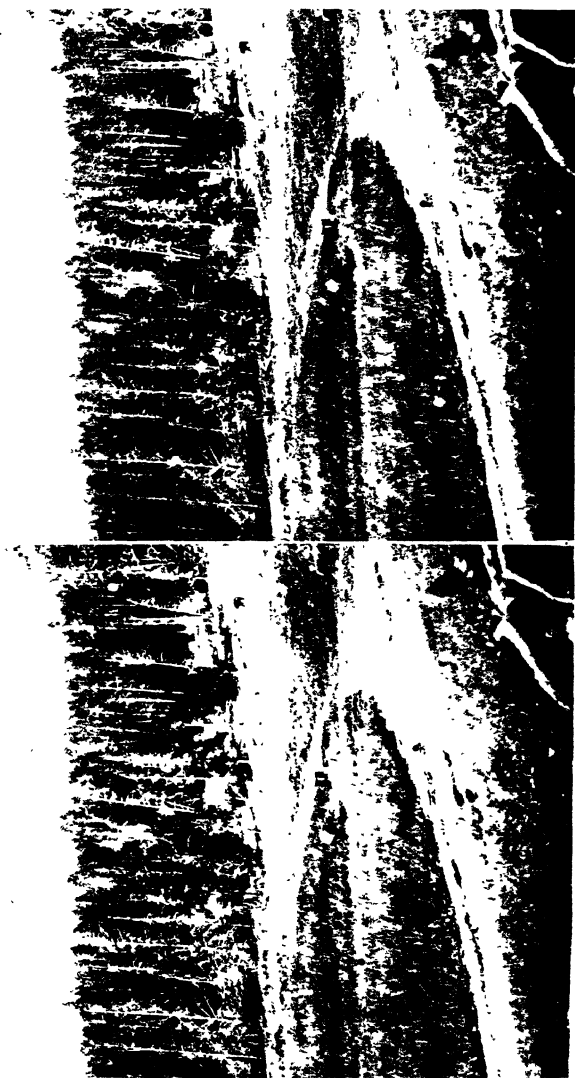
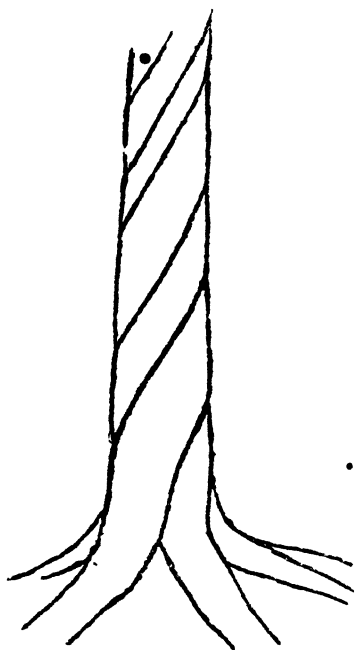


Fig. 1. B. n. photograph taken within the mountain wall of the Tectonic Hole (Lower Geyser Basin, A. P.). The heap of rocks can be seen on the left.

turned out of the main trail for some distance, to visit the "Lone Star" geyser, which kindly treated us to a fine eruption (*vide* Plates XVI. and XVII.). I hope my photograph of the cone of this geyser will give some idea of its great beauty.

We crossed the divide, and on this part of the drive I noticed first how the cracks on the pine trunks are almost all spiral; and not only so, but almost invariably go from left to right, beginning from the root end, thus :—



I asked the driver if he could explain this, but he only told me that he had often heard it debated, and that it was supposed to be due to the vibration of the tree under the prevailing wind. This does not seem to me to explain the *direction* of the screw at all, for if a wind blows

on a tree it does not appear more likely to make a screw in one direction than in the other. Now and then I noticed a screw from right to left, but not more than six cases to over a hundred of the other. At first, I thought it might be due to the unequal heating of the trunks by the sun, and perhaps it is really caused by this ; and yet the sun scarcely reaches many of the trees in the wood, and it is difficult to see, if this is the cause, why there should be *any* exceptions, as the sun always heats the southern side most, and, moreover, always goes from east to west. I notice, too, that the cracks roughly form the boundaries of the continuations of each main root trunk up the body of the tree, so that the pine resembles a cord, the strands of which are twisted in a screw of very high pitch. This must evidently give wonderful play to the tree under any twisting forces, and make it able to bear the asymmetric heat of the sun — and consequent asymmetric expansion — without splitting, for every strand at some point of its course comes to the sunny side, so that the effect of the sunshine is to make *all* the strands longer, and hence to make the tree taller on *every side*. Conversely, in winter time, contraction must knit the strands tightly together, and thus, probably, this spiral arrangement acts as a protection to the tree from the effects of both heat and cold, as well as of the wind. Now the effect of any force in nature is very often, though not always, such as to make the effect of a second application of the same force *less* than the effect of the first. For example, if a soft mass of clay is compressed in a



Figure 1. The person in the white shirt and dark pants.



Eruption of the "Lone Star" Geyser. The cone is about 10 feet high, and striped with various shades of white, yellow, brown, and lilac. The water is ejected to a height of about 50 feet.

mould by a series of equal blows from a hammer, the very compression produced by the first blow will make the clay more able to resist the second, and so on, until finally the blows produce no further effect. It follows, therefore, that where a system has taken a form by which it is able to resist certain forces, it is at least not unlikely that those very forces have caused the arrangement.

Hence we may reasonably suppose that it is heat and possibly prevalent wind pressure which have caused this spiral arrangement, and further that the prevailing direction of the screw (right-handed as seen from the root looking up the axis of the tree) is due to some cause which affects all the trees alike—such as the rotation of the earth from west to east—and the fact that the trees I have examined are all in the Northern hemisphere. If this is the case, then most trees should have a left-handed screw in the Southern hemisphere.¹ The few cases of left-handed screw observed, may very well be due to these trees being shaded by others or by rocks, &c., on their south side, and open to the reflected heat of the sun on their northern sides. As far as a hasty glance at the surroundings of two of these left-handed ones could tell, this hypothesis seems to tally fairly well with facts. But to explain the exact way in which the spiral is formed, even if one's conjecture as to the cause is correct, is not at all easy. The effect of heat in expanding the wood may be quite negligible in comparison with its *drying* effect, which would give, on the whole, a contraction;

¹ The writer has not yet been able to get any information on this point.

as the sun shines first on the east side of the trunk, and then on the south, and finally on the west, it might be supposed that the spiral would follow the course of the sun, but this is precisely what it does *not* generally do.

I observed many hundreds of trees for the direction of their twist, before leaving America, both in Yellowstone Park, in California, in Colorado, and in the neighbourhood of New York, and though I find a very decided majority of what I call right-handed trees, like those here mentioned, yet in some places, notably on the way to Seven Lakes, above Loch Marie, in the Pikes Peak district, I came across large groups of left-handed specimens—and that too in all sorts of positions with respect to the slopes they grew on and their orientation. So that I cannot offer any explanation. These curious twists extend to the whole “grain” of the wood, and are important—since it is only those trees whose wood is free from twist which supply good timber; and I was told by more than one backwoodsman, that the very first thing a woodcutter does when he wishes to fell a tree for timber, is to remove a piece of the bark and inspect the surface beneath for twist. If the cause of this spiral arrangement were therefore understood, it is likely that some treatment might be devised whereby its development might be prevented, or at least greatly reduced. I am personally inclined to believe that it must have its origin in the structure of the seed, and so perhaps be transmitted by a tree to its offspring. This would perhaps account for trees of similar twist so often occurring in groups.



CHAPTER III



AFTER leaving the "Lone Star" geyser, we drove up a lovely cañon—Gibbon's, I think—and at its head saw for a few minutes the grand Teton Range (14,400 feet), rising pale grey, but sharply defined, 75 miles away. Crossing the watershed again, we looked down for the first time on the broad and lovely Yellowstone Lake. Its waters were a light cobalt blue, backed by the picturesque, dusky red range of Absaroka Mountains, fully thirty miles off, one of the four great natural barriers of the "Park." Pine forests slope down to the yellow strand on every side. A patch or two of snow lay blue in the faint haze on the upper slopes of the distant hills, and scarcely darker gleamed tracts of geyserite at their feet. Through the tree-tops belows us could be seen white canvas tents, and at a jetty, thrust out but a few feet into the water, lay a small steamer, the first (though I fear not the last) to float on these far-away, secluded waters.

Lunch was served in one of the tents, and after visiting the mud volcanoes, and the hot springs of soft water which lie on the very margin of the lake, some of them indeed *in* it, we went aboard, leaving our driver to take the longer road to the hotel at the south end of the water. The sun was broiling hot, and the awning on the boat most welcome. Rapidly the tents and trees, the beach and pools, receded from us as we sped over this wonderful lake, 8,000 feet above the sea. If you look down into its water, it is the colour of summer fields of grass, and crowded with small, yellowish-green, gelatinous particles, which the captain said he believed were the pollen or seed of some water plant. These only appear in August, and are declared—according to the captain—by two well-known Professors, to be the pollen of the pines, which has been blown into the lake. I suppose the Professors did not give their opinion without duly examining the “pollen” microscopically, and if its identity with the pine product has been proved this way, no more remains to be said. Still the captain remains a sceptic. Whatever these little particles may be, there is an astonishing number of them, for they seem to fill the whole lake, so far as we could see; and I could not make out that they were any more numerous near the south shore and its pine forests, than further out—perhaps because a moderate south wind was blowing whilst we crossed.

Yellowstone Lake possesses many attractions, not only lovely fjord-like arms, running far up towards the mountains, but several wooded islets,

on one of which we landed. Before getting ashore, we could see an antelope walking along quietly by the water's edge, inspecting us—it seemed almost tame, though it was in a perfectly natural and wild condition, and had never been in captivity. When we landed, it retreated several yards, but then came slowly back, and allowed its nose to be stroked, but not its back; at any attempt to do this, it showed a strong inclination, first to butt and kick, and then to run away altogether. There are wild elk and buffalo; one of the latter—a huge old bull—lives in the same island. I got a photograph of him, and of one of the antelopes, through a wooden palisade put up to prevent mischief, if visitors prove unwelcome to these powerful creatures. As it was, the bull was in by no means a pleasant mood, and at the very moment at which my photograph was taken, he was meditating a charge, I believe, at some of the *other* visitors. Such splendid specimens are getting rare now, yet not so very many years ago the plains about here used to quake under the steps of tens of thousands of them, as they swept by in vast herds before the huntsman or the prairie fire.

Hardly had we left the shore before we spied two large white birds sitting on the water some distance ahead; at first I thought they were geese or swans, then their heads came into profile with their enormous beaks, and left no doubt as to their kind. They were pelicans, fishing for the trout with which these waters literally swarm. Fishermen are never disappointed with Yellowstone Lake, and in one place,

a spring of boiling water, the crater round which actually rises from the marginal water of the lake, makes it possible and easy to cook your fish as soon as you have caught him. The pelicans rose from the lake as the steamer approached, and with lazy flappings flew off to a number of their kind which we could see standing idle, or fishing, or eyeing the water, or resting uncouthly in the sun, on the sandy shore of a promontory some six hundred yards away.

Shortly after four o'clock we landed, and went exploring along the lake shore, picking up some interesting-looking pebbles, and gathering unfamiliar flowers in the meadows hard by. There are many bears here too, which are fed as at the Fountain Hotel, but after dinner we had other things to do, and did not go out to see them. Two sturdy cubs lie in the back yard, tethered to poles. They drink and bathe in sunken water-buckets, and share one kennel. I heard that a lady, who, I suppose, over-estimated her courage, went up to play with one of these little creatures, and when the cub came running straight towards her, in sudden fear she backed into the bears' tub, at least half full of water, and that, too, not particularly clean! I saw one of the cubs sitting in the tub, with its head just resting contentedly on the edge, an inch above the ground. It looked the very spirit of mischief.

On Thursday morning we made our start for the Grand Cañon. The road leads through pine forests the first part of the way, without any specially interesting object, until after passing a hot spring on the left (which used, so they say,

PLATE XVIII.



Crater of the Mud Volcano, Hayden Valley, N. P.

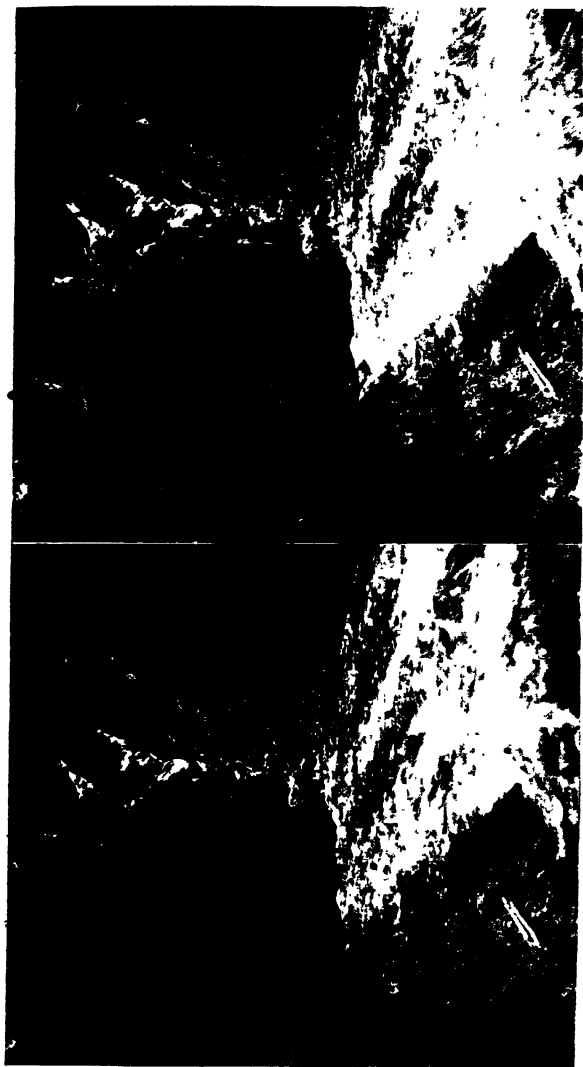
to be a mud geyser), the mud volcano is reached on the same side. It is a place which would be horrible to any one the least superstitious, and to the most matter-of-fact person, the thought of the fate which would befall him should a false step or treacherous ground cast him into the crater, must greatly strengthen the impression the funereal colouring of the pit cannot fail to make. It lies on the side of the hill, the ground having fallen in to a depth of forty or fifty feet. In the lowest part of that side of the crater which is most deeply cut into the hill is a very dark cave; the floor of this is of boiling mud (*vide* Plate XVIII.), the consistency of rather thick mortar. Every few seconds this heaves up into a large convex kind of bubble, which the imprisoned steam blows to pieces with a muffled explosion. The mud is projected more or less violently forwards, part on to the opposite side of the crater, which is thus kept moist and sticky, while part falls with a sloshy noise into the mud coils which form the level floor. Every eight or ten minutes this monster has paroxysms, when its dull thunder may be heard for a quarter of a mile, and ground shakes all round its mouth. It is condemned to swallow its own mud, until the restless Fire Spirit below grows cold, and the volcano's throat is choked by the solidification of what it has ejected. A short distance away is a spring, which repeats exactly the action of the mud volcano, only in this case what is thrown out is not mud but water, and this little water volcano is on a very much smaller scale.

Before reaching the cañon, the road runs

between low, rounded hills, almost devoid of trees, formed of clay, with water-worn stones, and occasionally carved into well-defined terraces. The placid river shows no sign of what is coming, until just before you enter the rather insignificant gorge, which is really the beginning of the cañon. There its waters suddenly break into rapids. Between the pines you look down on large rocks lying in lines across the river bed, with the stream flowing fast between them. Then comes more foam, and then a ledge of water, over which the river seems to disappear into space (*vide* Plate XIX., which shows the corresponding ledge of water seen from the approach to the *Lower* Fall), for the eye catches sight of nothing beyond but a comparatively distant fir- and pine-clad cliff. The roar of the Upper Fall—which lies here—breaks on the ear, and a minute later, as you pass over a trestle bridge above a graceful cascade made by one of the Yellowstone's small tributaries, a first view of the upper part of the marvellous cañon greets you; enough is seen to arouse keen expectation, and then it is practically hidden by the thickly clustered pines, and so to the hotel.

Directly after lunch we walked down to Look-Out Point, and though the view from this favourite spot is not so comprehensive as that from Inspiration Point, or from some of the others near, it is a great deal more than the mind can grasp, even after prolonged gazing and mental measurement of heights and distances. Far below where we stand, five young eagles are sitting in their nest which crowns a vertical

PLATE XIX.



The Brink of the Lower Fall of the Yellowstone River.

[To face p. 82.]



The Lower Fall of the Yellowstone River, and Yellowstone Grand Cañon, from Look-out Point.

[To face p. 84.]

pillar of rock, part of a ridge several hundreds of feet high—one of the many buttresses which support the tremendous thrust the walls of this wonderful gulf must exert. One of the parent birds is flying in great circles in the cañon air, so clear that it makes it impossible to judge accurately of the distance of those seamed mountain walls which tower up to our own level just opposite. The white head and dark-brown back of the other bird are to be seen almost vertically under our look-out point, where it sits, still as a statue, on the top of a tall bare pine trunk, foreshortened so, that—but for the length of its shadow—it might rise only a few feet above the soil. The eagle is watching intently the deep blue waters of the Yellowstone River, as they flow with a sullen, distant roar over the rocks which have fallen to the lowest depths. On the right, embedded in the very heart of the shadows into which the sun—already sinking—throws these giant cliffs and pinnacles, lies the Lower Fall (Plate XX.), in reality a broad white pyramid of foam near four hundred feet high, but dwarfed and coloured by distance to a dash of faint blue, below a finest line of twinkling gold, in sombre azure setting.

On the left, in a glare such as you must see to believe, with the sunshine falling full on them, rise Titanic walls, parapets, turreted castles, spires, and towers—their foundations in the shadows now creeping along the river and up the sides, while their upper steeps are all of glowing yellow and dazzling white, with here and there a sweep of palest apple-green. Half-way

down their hues deepen into orange, red, and the crimson of blood ; whilst in places groups of pines—looking little higher than bushes—relieve and intensify, with their dark foliage, the weird tints of their mother soil.

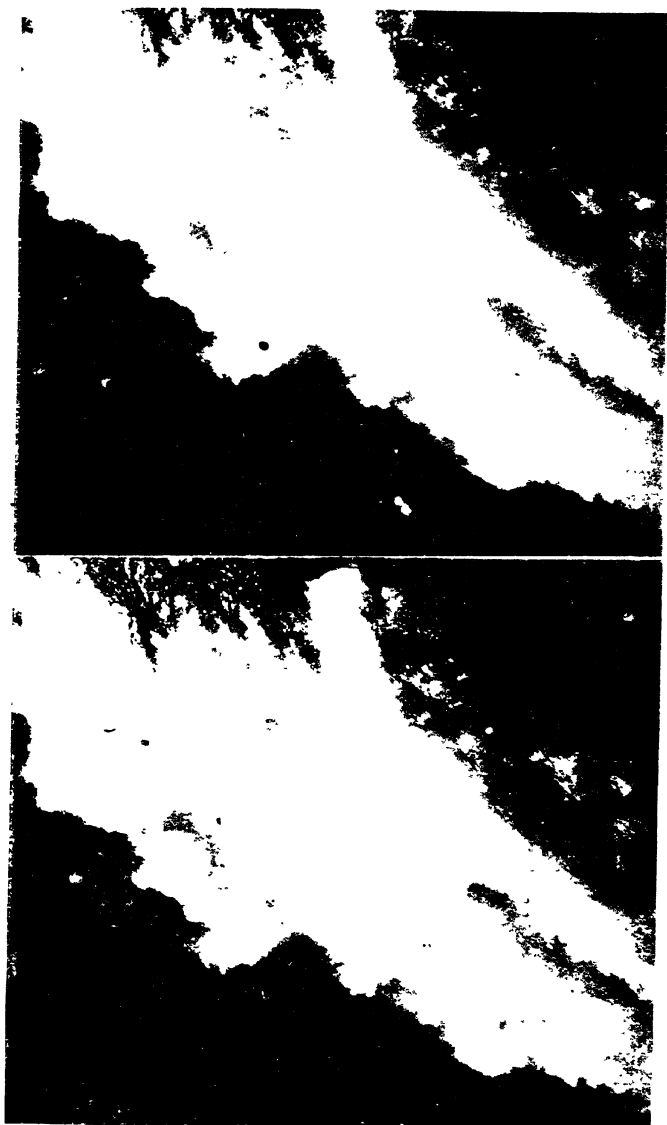
Slowly the evening shadows climb the radiant wall, as they have done for countless years past ; the eagles gather to their nests, whilst, as the twilight deepens, bears, woodchucks, ground hogs, and other beasts of prey, prowl amongst the trees on the crumbling slopes as of old ; and all night long the rocks reverberate the ceaseless, ancient voice of troubled waters, ever lengthening and deepening their age-long work. Few are the scenes which last in memory, even through our brief span of life, but I think the Yellowstone Cañon is one,—so savage and unearthly in its colouring, so gigantic in its proportions, so utterly indifferent to, and independent of, man. (Plate XXI. The cañon from the brink of the Lower Fall—looking down the valley.)

That night we felt thankful that we had set aside a spare day to be devoted to the cañon ; and by next evening still more so, after viewing the Lower Fall from its brink (Plate XXII.), and from a rock about a third of the way down the side of the cañon, to say nothing of the grand drive to Inspiration Point.

On the drive from the cañon to Mammoth Hot Springs, although the scenery is pretty and interesting almost all the way, there is not very much to record. Virginia Cascade, a long water slide in a small cañon, looked lovely in the morning light ; and in the border of the wood



The Yellow Lake (upper) and (lower) beds.


$$\|u\|_{H^{\frac{1}{2}}(\Gamma)} \leq \|u\|_{L^2(\Omega)} + \|u\|_{W^{1,p}(\Omega)} = \|u\|_{W^{1,p}(\Omega)},$$

we spied a black-tailed deer. We spent some time at the Norris Basin, but the "Monarch" had played in the night, as the wetness of the ground all round the geyser showed. The "vixen" I watched awhile, her short, spasmodic outbreaks recurring every fifty seconds. Between the Norris Basin and Mammoth Springs I photographed the Beaver Lodge and dams (Plate XXIII., which shows the dams running right across the northern end of the Lake), in this case made of mud and grass firmly plastered down; and, on reaching the Mammoth Hotel, spent several plates on Pulpit (Plate XXIV.) and Minerva Terraces (Plates XXV. and XXVI.). The light was bad for the latter, and I fear, in spite of the yellow screens, there will be a sad lack of contrast in the pictures.

We both admired the terraces on this second inspection much more than at first, and thought that our guide had missed conducting us to the most beautiful parts of the formation when first we visited them.

After a great hurry-scurry of packing, and a desperate attempt to get some food, we ascended the coach steps, and in two hours, in the dusk, reached Cinabara. There the Y. & P. Transport Co. hurled our baggage out on to the far end of the platform, whilst the railway officials refused to move it nearer the office, as they said it was not their business; however, after a few remarks on both sides, and some kind help from an indignant American fellow-passenger, I got it checked just as our train for the West was moving off, and

once again we settled down to the comparative quiet of the train for four days.

The first part of the way lay through wild and sometimes beautiful country, almost uninhabited, the hills for the most part being bare, and not very high. Often we skirted the sandy shores of a large river, edged with brushwood and stunted firs ; but before Portland, where the weather was very hot, we began to enter the magnificent forests of the West. At Hope's Fork, where our river joined the Columbia, the scenery was exquisite, and the lake one placid sheet of gold under a wonderful sunset sky.

Early next morning the train ran on to a terry, and we crossed the Columbia in the same way as we had previously crossed the Mississippi, on the wide ferry-boat. The Shasta route proved rather disappointing on account of the forest fires, which had engendered such vast volumes of smoke that for miles the view had no distance in it, and the sun only just showed through as a deep blood-coloured disc. It was very hot too ; even in the observation car, which is open on both sides, a dry, hot wind blew. Evening overtook us as we were slipping down a deep wooded valley, alongside a brawling mountain stream, fed partly by the medicinal springs of Shasta ; and on each side a thick growth of huge pines, firs, and underwood, including bushes red with gooseberries, the little branches quite borne down with ripe fruit, all the more tempting because we could not get at them, and, I am bound to add, from the fact that all the food provided on the train was execrably mouldy.

On Wednesday morning, under a gloomy sky



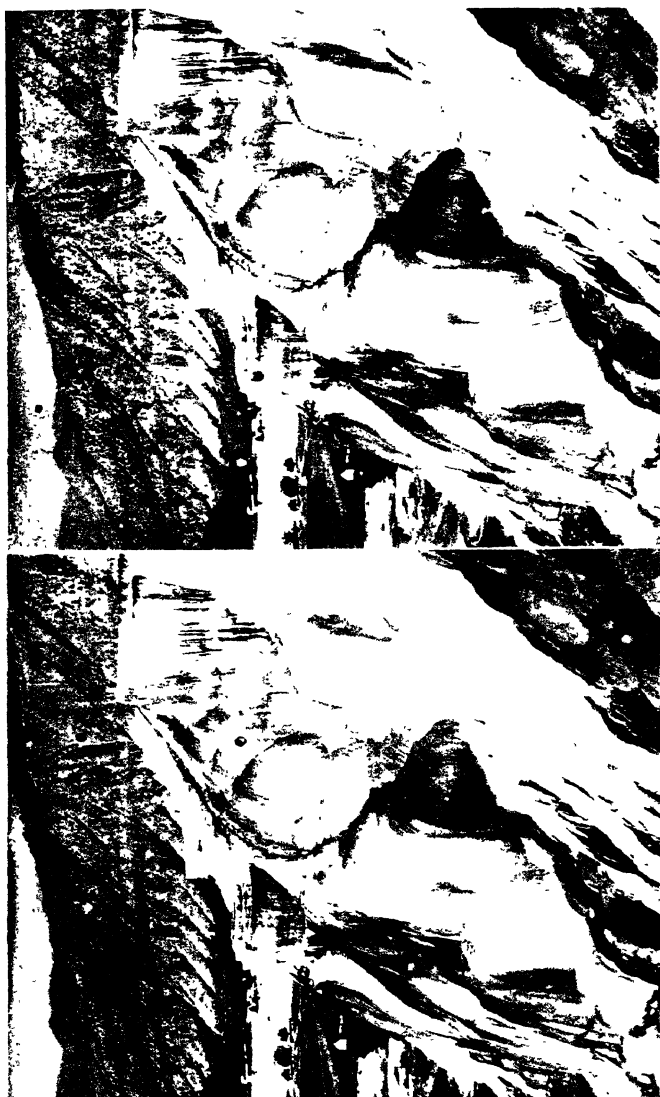


Photo: Tessa - Mammals Hot Spots - A - 1

and a cold breeze, I had my first glimpse of the Pacific ; not, indeed, of the open ocean, but of the long, almost land-locked, bay of San Francisco, whose entrance is the world-famed "Golden Gate." The water here was brown, streaked with yellowish-green, and small leaden breakers curled in on the wide and flat mud shore. The train rapidly rounded one little headland after another, the sea becoming greener and then more blue, till Oakland, from the railway a most uninteresting-looking manufacturing town, broke upon us.

In the station we got out, walked by a broad, covered way on to the large steamboat ferry, and for a quarter of an hour were crossing the green waters of the Bay to 'Frisco itself. We felt the change of temperature keenly after our late broiling suns ; and though, I expect, the thermometer was not below 50° F., it seemed like winter. Every one was warmly dressed.

San Francisco struck me at once as a fine city. It lies at the bottom and all up one side of a rather steep hill, and the wide, white streets, running as straight as lines can up this hill, give it a curiously streaked look when seen from the sea. It is far more countrified than New York or Chicago, and the cobbles in the streets are the worst I have seen in any town or village. Driving is made still worse by the level square crossings of the car lines, but the streets themselves are very wide, airy, and spotlessly clean, and the buildings fine and tall. The traffic produced no inconvenient crowding either, nor did the people seem particularly intent on any business.

They say this city is always cool, and that this

is caused by a cold current which hugs the coast all the way down from Alaska. Perhaps this is part of the warm Japan current which has become cooled far up in the North, and which, after returning South, down these far Western coasts, is drifted by winds to the West, again joining the Black Current of Japan (Karo Sivo), and so completing a vast circulation of water akin to the Gulf Stream. We bumped along to the Palace Hotel, a very fine building and very large. H. set to work to rearrange luggage, whilst I paid visits to ticket-offices, bank, and Kahn's, a photographer, where I gave an order for four dozen of Seed's well-known plates to replenish my fast diminishing store. This done, we took the car to the Park and Cliff House. The former is very beautifully laid out in wide gravel drives, with noble borders, planted with all kinds of shrubs, trees and flowers. Many of them reminded us of home as we walked along, but, pressed for time, we could not stay long, and reserved a closer inspection for our second visit, which was duly paid some days later, when we visited the aviaries, by far the best I know of, and some of the animal houses.

Cliff House looks out over the Pacific; the breakers were rolling in grandly on the sandy beach, throwing up clouds of spray near the seal rocks. These last are a few mewstones, and their ledges are thickly covered with large brown seals, most lying lazily, but one or two with their heads raised high in the air, sometimes waving them from side to side like captive polar bears. After dinner, at which an orchestra played, we

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Figure 1. Photograph of the Mammalian Spine, H. 1. 1. 1.



returned to 'Frisco by the electric car, with its clever overhead wire and fishing-rod contact maker, and leaving the heavy luggage behind, crossed the water to Oakland, and there took the cars for Yosemite.

-- By break of day we were at Raymond, a small country station, with an inn opposite. Thence we started, when we had had breakfast, in a covered little "Surrey" for Wawona, which we reached after an exhausting and dusty drive of forty-four miles, uphill almost all the way. In the first ten miles or so, we saw bluebirds, magpies, scores of squirrels and "chipmunks" (as they pronounce them), some very tiny birds—the smallest I have ever seen—a kind of wren; red-crested woodpeckers too, which make holes in the trees and fill them with acorns, one to each hole: the grubs come from the trees into the acorns, the industrious pecker visits the holes from time to time, and when the acorn is inhabited picks out the worm and eats it. We saw one bird flying with the acorn in its mouth, and many of the holes already filled. Very long-eared hares and rabbits we also met with, and renewed our acquaintance with the ground chuck.

The country, so far, was a series of gently rounded low hills, covered with a shallow soil from decomposed granite, on which grew hundreds of ilex and oak trees, with thin grass and many flowers between them. Michaelmas daisies and sunflowers were the commonest. Next, came higher hills with many gold mines, some now unused but most in full work, with clusters of log-huts and rather pretty-looking

lodges near them. Grub Gulch is the largest we passed. After lunch at a most charming country inn, and a change of horses, we began a seemingly never-ending hill ; and about three o'clock struck timber, not to leave it during our whole stay in Yosemite. Of all the many wonderful and beautiful things this tour has already shown us, perhaps none will live more vividly in memory than these aged pine forests, which dwarf the road to a mere pony path, and often rise with never a bough or leaf for a hundred and fifty feet on both sides of the way, like the pillars of some vast cathedral, and then break into graceful foliage almost meeting overhead. Thus we could drive in deep cool shade on the hottest days. Morning and evening, shafts of light penetrate the lattice of the leaves in places, picking out, here the lovely fronds of some young silver pine, there the graceful fringes of a cedar. The many different species prevent any feeling of weariness : perhaps the sugar pine is the finest of all, with its dark tufts and its huge cones ; but it is very difficult to decide. Anything more exquisite than some of the young cedars I never saw ; and even after driving hour after hour through the woods we still gazed untired, and could not repress exclamations of wonder and delight, as bends in the winding road showed ever new vistas of beauty. Of the road itself—especially of the descent to Wawona—the less said the better. One of the awning supports, a piece of very fair cast-iron more than a quarter of an inch thick, broke off short from the jolting, and I fancy that if we had either of us been weak, we

should have experienced what our American cousins call "car sickness." We executed every kind of known motion, short of spinning round, and wondered at the strength of the lightly built wheels, which had, however, as many as twenty spokes each ; and so, just before sunset, we rattled down the last sandy slope, and found ourselves among the fountains and gardens of sunny Wawona. That evening, in a cellar, I changed my plates and arranged with the kind and genial host how we had best spend our time in Yosemite.

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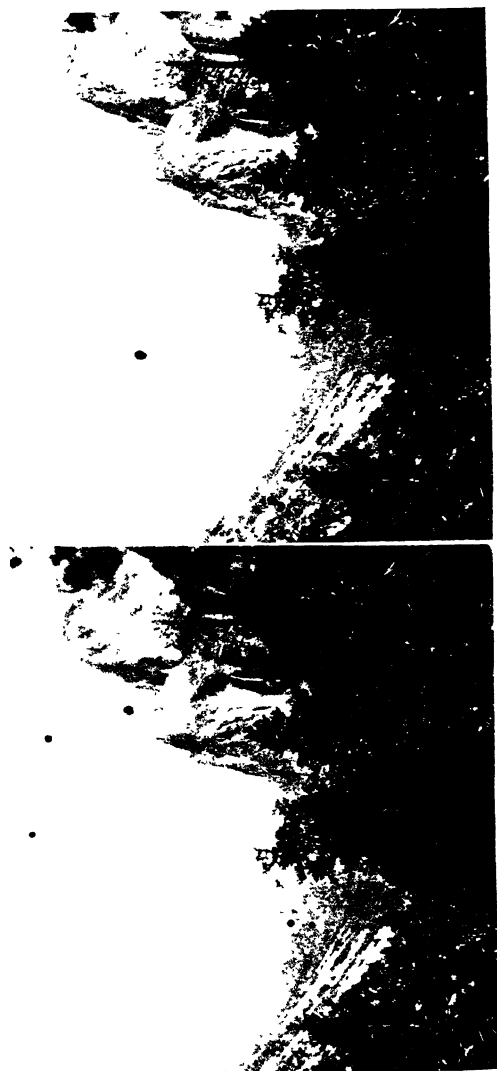
CHAPTER IV



EXT morning early we started again, this time in an *open* "Surrey," for the twenty-seven miles drive to Sentinel Hotel, which lies in the heart of Yosemite Valley : we chose an *open* "Surrey," as it is really important, on this road, to be able to see uninterruptedly what lies above, as well as in front and on both sides of the carriage.

The trail lies along the sides of the Sierras' outliers, and until Inspiration Point is reached the views may all be described in one word—trees. The rich brown pine trunks in the foreground frame the pictures, the bark of some of them golden yellow with lichen : there are trees in mid-distance, countless spires of green and silver ; trees far away, hills and mountains of them, all detail lost in the blue of the air and the haze of the forest fires, so that only the fine serrated sky-line betrays that they are there. In places the hill-sides are covered with fallen giants, the trunks crossing each other at every conceiv-

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able angle, most of them stripped bare of bark. The cold greys of these withered glories of the forest make the foliage of the rising generation glow all the more brightly. The wheels squeak and groan under the heavy brake, as we descend some steep slope where the road is broken into holes, not to mention ruts a foot deep, and large stones concealed by the orange dust. Deep glades open at every turn—banks of the coolest shade—and out of the ground, overstrewn with slippery pine needles and clusters of cones, arise the blackened stumps of the victims of forest fires, taking the shape of long-eared rabbit or begging bear, objects quite startling in the gloom.

But the gorge below us is becoming steeper and grander, the trees along the edge of the road less and less thickly clustered, and presently, as the driver pulls up on a little knoll of rock and grass, the glorious Yosemite lies spread out before us (Plate XXVII.). We are scarcely in the valley itself, so that distance softens the whole view, blending into one harmony of colour the stark pinnacles and precipices, the bleak far-off peaks, the gleaming streak of waterfall, and the cool, broad forests, deep in which the mountains on either side bury their feet. In one glance at such a sight the discoverers must have forgotten all their toil; and as a man gazes on this valley, so old and yet ever young—on its walls, scarred and lined where the ages have written its history in yet almost unknown characters and language—on its forests, descendants through generations of centuries of those on which the towers and cliffs first looked down, he seems to see before him the long-lost

Garden of Eden, and to hear the echoes still lingering over those ever thrilling words: "God saw everything that He had made, and behold it was very good."

To me this particular view of Yosemite recalled the Norwegian Naerodal (*vide* Plate XXVIII.); that far-famed valley is the only one I have seen which will at all bear comparison with it, and though there certainly is a likeness, and that too in more points than one, the two are so far different in general character, that to see one would not make it possible to picture the other. In both, the ice of now perished glaciers has given to mountain-tops a regular dome-like form; perhaps the "Jordalsnut" takes the palm for perfection of geometrical shape, its graceful curve from head to foot making it impossible to say with certainty where the curve of the dome itself begins or where it ends, and whereas it is of pale violet Labradorite, the domes of the Yosemite are of a light yellow granite. The actual depth of both valleys is about the same, but the Naerodal is much narrower, and this makes the valley, as seen from Stalheim, look much deeper than the Yosemite viewed from Inspiration Point. In both the walls are of almost completely bare rock.

El Capitan is represented in the Naerodal by the tremendous precipice on the right of the dale, the Kaldafjeld; but this latter is not so clean cut, so frowning, nor so perpendicular as the gigantic cliff which guards the left of the entrance to the Californian valley. El Capitan, in fact, is in places more than perpendicular,—it



overhangs. Then again, the Norwegian valley is but seven or eight miles long, whereas Yosemite is over seventeen; but whereas the American dale ends in a *cul-de-sac* of very distant lofty jagged peaks, the wondrous half-dome cutting the eastern sky just to the left of them, its form completed in the North dome to the left again, the Norwegian dale becomes a magnificent fjord, the line of precipices, as seen from Stalheim, turning a corner behind which they are lost to view.

Strangely enough, both valleys boast four waterfall's, and in both, from the finest point of view, but one can be seen. In the Norwegian it lies in the distance, just over where the fjord begins, a thin white streak. On the other hand, the fall in Yosemite, visible from this point, is a strikingly beautiful feature of the view. On the right, and fairly near, this "Bridal Veil," as it is called, descends in a graceful line of sparkling foam, all but a thousand feet sheer. It is set in dark bare rock, and in the cloud of spray which borders the veil, the afternoon sun kindles a maze of rainbow colours. Perhaps this fall is most beautiful in the dry season, when the wind is playing with it, waving it from side to side, now spreading it out like a many-rayed fan, now holding it up suspended altogether in the air for a moment, only to let it loose again in one long fall of exquisitely pointed lace work.

On the opposite side of the valley, and further off, is the second cataract, of a different character altogether. Down the central line of a wild gorge, cut wide and deep into the main wall of

granite, which here is at least three thousand feet from base to summit, leaps the Yosemite river in two great bounds, from where the deep blue sky shows over the scarred edge, to the slope of *débris* with which frost, wind, and rain have hidden the lowest part of the cliff. Between the falls lies a large pool of water in a hollow to which the curious may descend by a zigzag path, and from which the finest view of the upper cascade is to be had.

A grand sight it must be when the river is full, and all the valley rescunds with the din of the heavy waters. In a storm, when the wind rages up the gorge in mighty gusts, it sometimes holds up in the air, for a second or two, even this great torrent ; and then, men say that above the roar of the tempest, and the hissing of the pines bowing before the blasts, can be heard the thunder of the pent-up waters as they tear asunder the air, and, gathering might in their descent, furiously hurl themselves into the dark caldron. How different, the tiny thread of silver, slowly threading its way amongst piled-up rocks blazing in the hot sun ; and the gentle murmuring of the little stream, gliding over the rounded stones, playing hide-and-seek amongst the boulders, until it flows noiselessly into the river Merced meandering through the meadows and woods which cover the floor of the great valley. So it was when I saw it : but the water-marks on the side of the grim precipice, and the wide bed of the stream, tell their own tale ; and even if there had been no photographs to help, it would not have been difficult to picture what this fall is in its strength.

The other two waterfalls, the Nevada and the Vernal, are also invisible from Inspiration Point—hidden by projections from the right side of the dale; they, too, are fine sights, and we explored them thoroughly later. And so we take leave of this first view of Yosemite, and again drive on down the increasingly steep road, craning our necks first to the left to El Capitan, and then to the right, where the Cathedral rocks and towers rise in red pinnacles and battlements till their topmost crags are almost vertically overhead.

Once arrived in the valley, the photographer is indeed hard put to it. Everything is so enormous, so hopelessly out of reach of any ordinary wide-angle lens, that time after time he gives up in despair the attempt to get a picture of scenery he longs to show to folks at home. The twin Cathedral spires, indeed, I took, with the ground glass anything but vertical, and I also got a view of El Capitan, rising like a rampart of heaven, dim and distant behind the pines; but the photograph, alas! will not give its colour, the palest of yellow greys, nor the silver radiance of the edge glistening in the sunshine.

About five o'clock we reached the Sentinel Hotel; and in a few minutes were driving towards the upper end of the valley, to get a general idea of the lie of the two minor valleys which run into the main, one on the right, and one on the left. We passed the spot where once stood another hotel, now burnt down, and, from just by the site, I took a photograph of the left valley, with the Dome on one side, and Mount Watkin (named after one of the most celebrated

of early American photographers) in the centre ; on the other side, but not included in the picture, rises Cloud's Rest and the Half Dome. At the foot of the latter, hidden by trees, nestles Mirror Lake. The view all round from this spot is magnificent. Turning further to the right, the Cap of Liberty imitates, on a smaller scale, the precipices of the Half Dome ; then follows the Nevada Fall ; then the stupendous face of Glacier Point ; and, with the Royal Arches, which are enormous curved recesses in a naked, unbroken precipice of nearly 3,000 feet, we come round to the South Dome again.

By this time the sun is low in the west, all the cliffs on one side lie in shade, yet not dark, for the golden glow on their rivals opposite lights them up awhile with a strange and wonderful orange light—but the army of shadows is scaling the heights, gaining one summit after another, till the last crimson flush fades from Half Dome and Cloud's Rest. The arch of night steals quickly up the eastern sky, soon it is overhead, then far down in the west where a bar of amber light is all that is left to tell of another bright day gone. Happy Island we did not visit—just now Miserable Isle would be a more fitting name, for a sudden fall of hundreds of tons of rock from the top of the precipice over it has buried its trees and ferns and flowers in dust seven inches deep ; so we drove to the foot of the Yosemite fall, and then made for our hotel, charmingly placed on the very bank of the river, into whose cool, clear waters we look down from the balcony outside our rooms.

Rising betimes at seven o'clock, we drove rapidly in the chilly morning air along the sandy roads to the foot of the Cloud's Rest trail, which begins near the once Happy Garden, and becomes steep directly. The guide rides a horse, H. a black mule, and I a bay, whilst a white specimen of the same obstinate species carries our lunch and the camera. The guide goes first leading the pack mule, which needs constant attention; then follows H., whilst I bring up the rear. Switches are necessary for all. The trail is a very dusty path, but never less than a yard and generally a good six feet wide, and in Norway would be called a carriage road; it winds upwards in bold zig-zags, and first gives beautiful views of the Vernal, then of the Nevada falls. Perhaps the outlook is finest just as you climb the side of the latter. The valley is seen framed on the right by the smooth precipices of the Cap of Liberty, which run down in very massive folds of granite and disappear into the pine-tops far below; and on the left, by the dashing water of the fall itself.

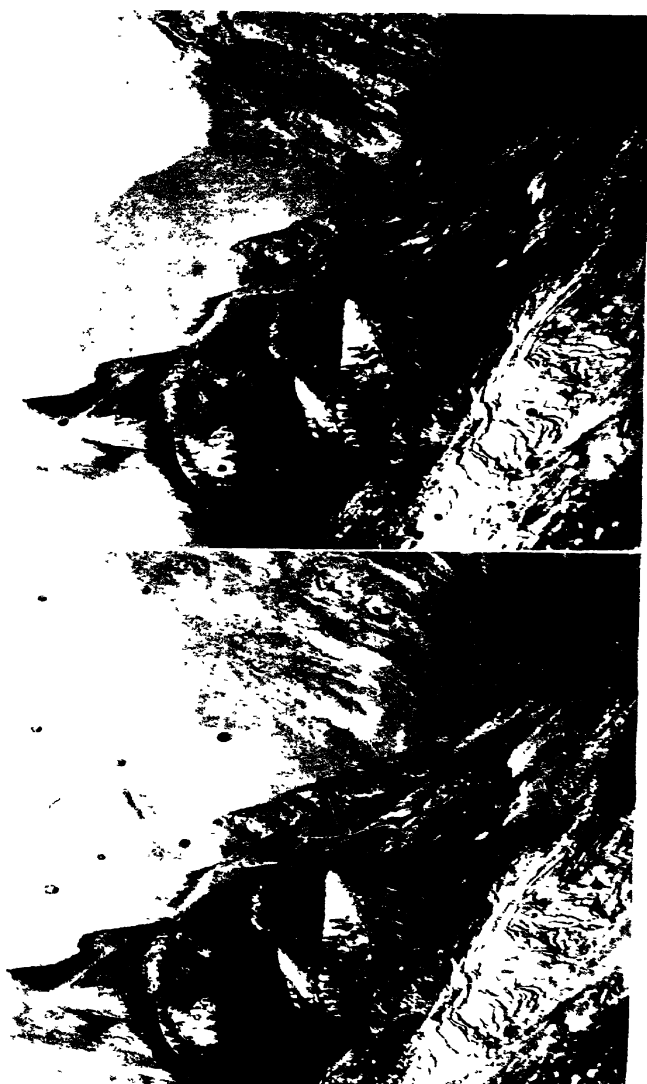
At the top of the Nevada we dismounted to rest the mules, and to look at the fall from a rock which juts out a little over it. All about this spot are huge ice-polished rocks, and perched far up on the top of a cliff we could just make out Glacier Point Hotel, where we hoped to sleep the next night. A dead rattlesnake lay in a shallow hole in the rocks, and reminded us of their presence. This is the season when they are most dangerous, for being sleepy they make no attempt to get out of your way, and if by accident you step on one, it strikes at once. I

saw a photograph of a man who had been bitten in the arm not many days ago, taken since then. He sucked the wound well, and then made for a camp as fast as he could, hoping to find some brandy or whiskey. The campers gave him all they had, but it was not enough, so he ran for dear life to a second camping-ground ; there too, though he could not get a really large dose, he left behind not a drop. Finally, however, he gained the hotel and its unlimited supplies, and there drank so much that he nearly died from *alcoholic* poisoning. Beyond the fact that the swelling of the bitten arm has not yet quite gone down, and that he still is suffering from headache, he has all but recovered.

Again mounted, for an hour or two we ascended more zig-zags, the trees growing thinner and the undergrowth thicker and thicker. From the final slopes the Half Dome is a superb object, rising in the most stately way imaginable, like some huge monolith (Plate XXIX.). From this side, too, it has lost its dis-symmetry, and seems perfectly inaccessible. Books, however, tell the story of the first ascent made by a man¹ who constructed a giddy staircase of iron spikes, one by one, steeple-jack fashion, using the last to stand on as he drove in the next.

The top of Cloud's Rest, which is nearly 10,000 feet above sea-level, is an almost flat tableland, covered with large granite blocks, very like the summit of Fanaraak, in the Norwegian Jotunheim. It is interesting to see how the granite weathers into similar shapes in countries wide apart.

¹ George G. Anderson, a Scotchman, of Montrose. This first ascent was made in October, 1875.



Many of the granite outcrops we have seen in America are facsimiles of those in the Scilly Isles, and on the Cornish coast. The profile of the High Sierra and of the granite mountains near Livingstone are exactly like those of the Scotch Isle of Arran, also of granite.

The view from Cloud's Rest is very wonderful, and of extraordinary interest to a geologist, as it shows what land is like when it has only lately emerged from an ice sheet. Restore the glaciers which once crawled slowly down the shallow valleys between the peaks, or lay quietly in the cirques or "botns," and you have the Norwegian Jotunfjeld of to-day. No glaciers are visible from either Cloud's Rest or Glacier Point, yet it is but a short time, geologically speaking, since they were there, and it will not be long, in the same sense, before the rounded granite bosses are disintegrated into a soil deep enough to support the stunted vegetation capable of living at this high altitude.

The camera came into play both for a group of peaks of the High Sierra, and also for the hazy Yosemite, still wrapped in drifting smoke of the forest fires near its entrance—fires, by the way, which my guide and others attributed to an incendiary (Plate XXIX.). A cloud, which has been gradually rising since the early hours of the morning, now makes it necessary to secure views quickly, if they are to be taken at all. Lunch follows, with the sun and wind beating upon us, and then we turn down the trail through the rocks, and rejoin the patient mules tethered below. Then the long descent begins, and it is

dusk when, after twelve hours of fairly hard work, we regain our hotel.

About eight o'clock next morning we drove to Mirror Lake to see the sun rise over the Half Dome, and to enjoy the reflections of mountain, cliff, and wood in the water, which at this hour is generally without a ripple. The road runs right up to and along the western shore, and the most beautiful view is the first, which greets you quite unexpectedly. The sun had, of course, long risen on the surrounding country, only the blue precipices of the Half Dome shroud the little lake in shadow, so that the reflected picture has plenty of sunlight in its distances to relieve the deep shades of the foreground. All is quiet, the birds still asleep, the mirror so perfect that in the camera the picture (which, as every one knows, is inverted) for once seems the right way up. A foot or two below you lies moist dark-red sand, then the water, broken by boulders of picturesque shapes and colours. Here rests a fallen tree, there a tangle of brushwood, every twig and leaf pictured below (Plate XXX.). Further away stretches a wide sheet of light azure crystal; already cranes are wading in the shallows on the far shore; presently, one with lazy flapping flight makes for some more lonely spot. Now some wild-ducks are taking their morning bath. Over the mountain on the right the light is brightening: the sun's rays glisten on the dew which hangs from leaves low down near the water. A few minutes pass, and the brilliant edge of the King of Day rides above the edge of yonder curved summit, and in an instant all is bathed in glorious.



light and warmth. It is this sudden change which makes it so well worth while visiting the lake at this particular hour, and it must be seen to be realised.

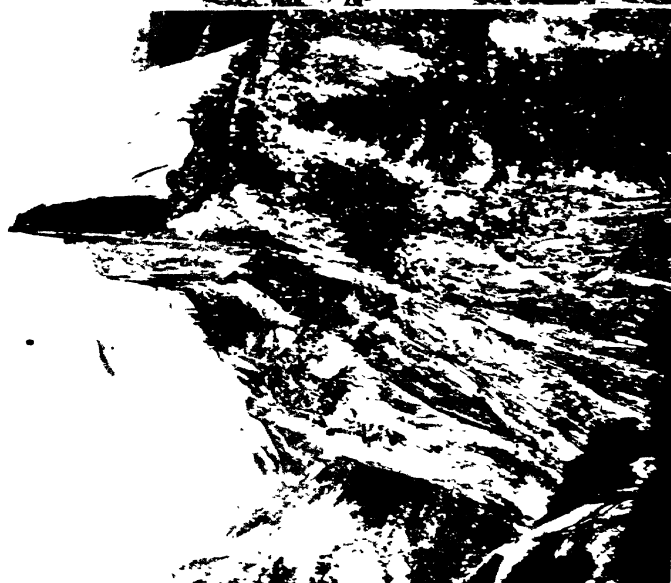
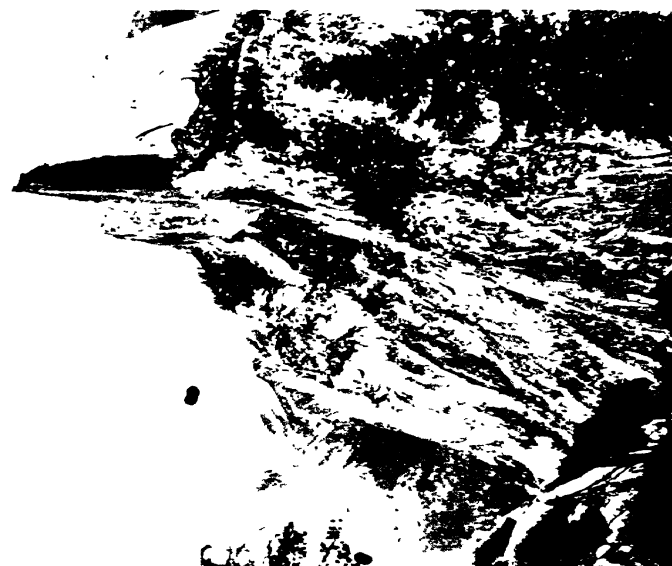
We drove back past the hotel, and to the foot of the trail to Glacier Point. No one should think he knows Yosemite until he has ridden or walked up at least one of the trails. It is from these that the valley is seen to the greatest advantage. Viewed from its floor, the fore-shortening of the upper part of the cliffs is too great to be appreciated, and so makes them appear much lower than they really are; but from about half-way up one side of the gorge, the opposite wall shows its true proportions, whilst the pictures are exquisitely framed by pine and oak, or by the bold lines of the scarred mountain buttresses.

The trail we are taking is even better than yesterday's, and the views as we near the top are wonderful in every direction. The bottom of the valley lies far below, spread out like some exquisitely coloured map. Of course the difficulty of estimating fore-shortening operates from the top, in making it very hard to judge difference of level of objects far below you in the floor of the valley, and so it appears much flatter than it is in reality. The mules rest at nearly every corner of the crooked path, giving their riders time to take in the successive pictures. Near the summit the ascent becomes less steep, and then leads at one level through the pine woods, still, however, keeping to the brink of the precipice; then it slightly rises again, and very soon after this the

modest little Glacier Point Hotel comes into sight, and with it the unique and superb prospect over the High Sierras (Plates XXXI. and XXXII.).

The central point of interest is the Nevada Fall, to which the eye invariably comes back, after roaming over the miles and miles of forest and barest rock scenery embraced in this one grand panorama. Under a noontide sun and cloudless sky, in spite of the waterfall, the pines, and the few shrunken snow patches at the foot of the distant peaks, it appeared the most parched and thirsty landscape I have ever seen. No lakes are visible, though at least one of considerable size—Tenieya—lies hidden away at the foot of the strikingly shaped peak of the same name; and though unseen from here, in the heart of the many valleys, all along the streams which flow from the melting snows, are green strips of land, gardens of flowers in early summer, as refreshing to the eye as are the cold rivers themselves to the parched throat of the traveller. But none of these are seen from Glacier Point, unless by turning to the left one happens to catch a glimpse of a dark indigo-looking pool, the mirror lake we visited this morning.

At this time of day there is no shade in the picture; it is at its worst. But wait till evening, and view it in the radiance of sunset—half the thirsty sea of granite hidden in cool blue shadows, the other rosy red with transparent purple depths, whilst the sharp peaks, all aflame with vermilion, blaze against a sky of pink and amber, which fast-coming night has already



begun to invade. Or again, stay overnight as we did, and see the dark-blue broken line of distant peaks clean cut against the dawn. Watch the long shadows of these monarchs of the Sierra as the rising sun flings them across the sky, the ever clasped fingers of the Night and Day, and, if such things appeal to you at all, you will never forget the sight as long as you live. After lunch we rode on mules, first to the Fissures, which are, in climbing language, very long, narrow chimneys, most likely eroded by the weather, in the sides of the Cathedral rocks. There are some half-dozen of these, one blocked not far from the top by masses of granite, which have been thrown into it. Through the rest you can look down hundreds of feet either on lower slopes of the same cliff, or on the diminutive meadows, the river and trees lying far below in the depths of the valley. Or, if the dizzy height does not affect you, you can stand out on the edge of some overhanging rock, and look vertically down a thousand feet at the spires of rock still two-thirds of the way up the precipice, as they rise towards you. If you drop a small stone over the edge, and watch it as it falls, it grows smaller and smaller and disappears altogether before striking bottom; and in places, fully ten seconds elapse before the sound of the impact reaches your ear, counting from the instant when you let the stone go. This gives for the depth of fall nearly 1,600 feet.

On the return ride we visited Sentinel Dome, with a fine view of the valley, and reached Glacier Point just in time to see a small cinnamon bear lurking behind the pigstye and poultry-houses.

This, they told us was not a frequent visitor by any means, though there are many bears, including grizzlies, in the high country beyond Yosemite. Two or three of the men ran out to try and find young Bruin, who had quickly disappeared, but could only trace him for a short distance.

In the evening, by the aid of a paraffin lantern, we walked to the Glacier Point, and sitting on a rock there, waited, whilst our guide lit the fuse of a carefully constructed bomb of blasting powder, and then hastily lowered it, fizzing and sputtering, by a long cord over the edge of the precipice. We stopped our ears carefully till the explosion had happened—which could be felt as well as heard—and then opening them, waited for the echo. It came with a crash and a roar, first from a point on the left, and rumbled along the wall of cliffs to the right, where from the two domes it resounded with the redoubled vigour of deep-toned thunder, rolling away in the distance as the waves of sound dashed themselves against the unseen array of peaks and precipices which surrounded us in the dark. Twice we awoke these wonderful echoes, and then groped our way back to the hotel well satisfied with what we had heard. If the ears are not stopped during the actual explosion, they are so far deafened, that they cannot hear the grand echo to advantage. It is, besides, much better heard at night when all is still, and reveals to the ear the immensity of the unseen scenery around, much as light shows it to the eye.

It was cold at night, but this was easily warded off, and in the morning about eight o'clock we



both felt sorry to leave the homely welcome and excellent fare we enjoyed during our short visit. The long drive to Wawona lay through forests for the most part, but I got a fine photograph of Cloud's Rest, which looks every inch a mountain from this road. The first part of it affords a magnificent view of the southern peaks of the Sierra Nevada. By one o'clock we were once more in Wawona, and after lunch drove to see the big trees, of which there are four groves in the district, the Merced, Tuolumne, Calaveras, and Mariposa. It was the last named we visited. The road at first is the same weary and dusty one by which we came to Wawona, and slowly indeed did we climb it in the hottest part of the day. Soon after passing the "black hare," one of whose ears had decayed off and had been nailed on again, came the turning to the left, with its large signboard "To the Mariposa Grove."

The excitement grew as we drove along, but the big trees were further off than we had thought. Meantime it seemed hard to imagine any much larger or statelier than some of the sugar pines we passed, yet when the turn of a corner showed us the two "Guardians" at the end of the road so far as we could see it, these pines, and much more all others, seemed visibly to shrink in comparison. It is this growing small of the trees one is accustomed to think of as giants, that reveals at first the immense girth and height of the "big trees" (see the Frontispiece, the "Grizzly Giant"). As the guide-book says, they are so exquisitely proportioned, that were there no others to judge

by, one would pass them at a distance without notice, if it were not for other qualities in which they differ from their neighbours, and above all, for their spotlessly clean and new-looking trunks. These are of the colour of an unpolished cedar-wood pencil, though perhaps a little redder. Boldly and handsomely grooved as a Corinthian column, they rise from spreading roots, with the appearance of invincible strength and uprightness, three hundred feet and more, tapering more slowly than the trunks of other trees, except for the first ten feet or so, in which their thickness somewhat rapidly diminishes from, say thirty feet to twenty or rather less. These wonderful trees are free from all the diseases to which their smaller neighbours succumb, and meet death only by repeated forest fires, by the woodman's axe, by the hurricane to which they never bend, or by the bolt from heaven. No wonder they reach a great age! Over four thousand annual rings have been carefully counted in a section taken of a fallen monarch, and that, too, by no means the largest tree. This, the present monarch of the grove, is still standing, and if its rings are distributed after the same scale, must be many centuries older.

It is the thought of all that has happened since these splendid trees were young striplings of the forest that adds such solemnity to their presence. Even when they have fallen, they lie in the trench their great weight makes in the soft soil many years without showing any signs of decay. Through the hollow trunk of one of these prostrate giants, three men may ride some





distance abreast on mules. The carriage way passes right through the middle of another enormous tree (Plate XXXIII.), thousands of years old, and yet apparently in all the freshness and vigour of youth. As one drives in the grove the eye instantly singles out the big trees, even where they are most closely surrounded by others. Most of them stand together in small groups (Plate XXXIV.) sometimes of as many as seven or eight, but it is difficult to get an uninterrupted view of a whole tree. Many have had their tops broken off by storms, so that few measure their full height. The branches are of a lighter shade than the trunk, and arranged rather like the flower-stalks of an aloe; the foliage, of a rich yellowish green, contrasts finely with the reds of the other parts. The bark, which is from two to four feet thick, when examined closely is found to consist of a mass of closely woven, soft, springy fibre. Pieces of it are used for pincushions. The cones are wonderfully small for the size of the tree, not being much bigger than those of the common Scotch fir, but more compact, and egg-shaped. We found many of them on the ground.

The sun was setting behind the pines before we could bring ourselves to say farewell to these beautiful trees, and so long as one of them remained in sight we looked at nothing else. The drive back in the darkness of a night without a moon was a new experience, and that we and our "Surrey" arrived safe and sound at Wawona is excellent testimony to the skill of our driver, who confessed that we should all have fared somewhat poorly if he had not known every

deep rut and hole in the road by heart. In the cool of next morning, about seven o'clock, with all our luggage on board, we began the long drive back to Raymond, hoping to keep, as we succeeded in doing, well ahead of the noise and dust of the stage. The only events worth recording are that we saw a rare and handsome bird, the Road-Runner, which kills snakes and can outpace a horse ; and that we almost ran over a small pink, earless pig lying in the road well nigh covered up with the dust, and a very sorry sight. Our driver thought it had been bitten by dogs.

The railway cars left Raymond about seven o'clock, and after running for an hour to Berenda, stopped there in a siding, where in the sleeper we passed the night, wakened early by a really severe concussion. This was caused by the train to which we were to be joined being backed into us in the most inconsiderate way. Most of the glass and crockery in our buffet car was broken. The evening sky had been a magnificent sight. I never saw the Milky Way glow as it did then, nor any constellations shine so brightly as Sagittarius and Scorpio over the western horizon. About one o'clock we regained the Palace Hotel and were going through our usual task of rearranging baggage. After another visit to the Bank, during which my escort refused to leave me, we paid our second visit to the gardens. The day was very fine but cool, and, much to our disappointment, the orchid-house was closed by the time we reached it, and no official competent to open it was to be found.



CHAPTER V



FTER dinner, I sallied out to see China Town with one of the official guides appointed by an inspector. We soon reached the Chinese quarter, and here one might just as well be in China itself. Everything is Chinese—shops, wares, and people. The few white faces in the streets look like foreigners, and one notices unfavourably the lack of a pig-tail! I thought many of the Celestials quite nice-looking, with their clear complexions and beautifully pencilled eyebrows. They are exceedingly clean personally, and think one bath at least a day as essential to happiness as any Englishman does. I think one sees in the perfectly cool, collected manner, even of the shopman, the evidence of a certain feeling of superiority : they kindly tolerate the patronage of the heathen, and comparatively ignorant, white man. He is so inferior a being that, suppose he is rude and overbearing, he is to be borne with, as a creature of a different and a lower world,

who has not learnt self-control, and is not altogether accountable for his actions! But none the less, they take no end of pains in showing their goods, and explaining the virtues of the same; and, unlike some shopkeepers of another nation, are not apparently the least chagrined, if, after examining their more curious and expensive wares, the customer ends by purchasing little or indeed nothing.

After visiting one or two shops, including a barber's—the barber was working scientifically with a small camel-hair brush on the ear of a customer—we turned our steps to the chief lodging-house of the quarter, a very large rambling old building, with a central court-yard set apart to cooking and sanitary uses, which, my attendant told me, is a great improvement on the old state of things, when the first was performed in the cells or rooms—whichever you prefer to call them—and provision for the second was apparently entirely wanting! The passages, on one or both sides of which the small rooms lie, are very narrow; and one tiny apartment will serve as the opium and sleeping chamber of three or four Chinese.

We paid informal visits to two or three rooms, and saw the Celestial enjoying his opium-pipe after the long day's work, for he begins at five or six in the morning and does not leave off till nine or ten at night. Reclining on his bed, a blanket or cushion placed on the shelf or floor of the alcove, with his body and legs in the shape of the letter G, the smoker takes out a small piece of the sticky prepared drug from a little jar on a metal

pin ; he holds it close over a lamp or a candle flame till it softens and bubbles, and then moulds it quickly with his fingers into a spindle-shaped lump. With the help of the pin, he fits this into the small hole at the end of the opium pipe, and then, slanting this down over the flame, inhales the vapour deeply as the plug of opium melts and vaporises in the heat. This goes on perhaps for an hour or two, until, as my guide put it, he becomes " full " of opium, when he extinguishes the light and falls into a deep sleep, and, in spite of what many say, awakes refreshed and invigorated for his next day's work. I only describe what I saw. I asked many questions, and came to the conclusion that most of these men enjoy their opium in almost the same way as many of us enjoy our tobacco, with as little or as great an ill effect. The Chinamen I saw were many of them big men, and anything but wasted looking, notwithstanding their cramped sleeping places. One of them possessed a cat, which regularly took opium with him, rising to inhale the opium smoke he blew from his lips with evident satisfaction, until it sank into deep sleep on its master's knees. When I saw the cat it was inhaling its last whiffs, and settled down for the night whilst I was looking on. They told me that this is the only known specimen of an animal in the world, except man, which takes opium.

I heard a small Chinese girl sing a song in Chinese, and then a short child's hymn in English, but on inquiring as to whether many of the Chinese are converts to Christianity, the answer was that many profess this religion for a time, in

order to learn English, and as soon as they have learnt it, reassert publicly their old religion, which they have never ceased to practise secretly all the time. Next we visited a Joss House. The so-called idols—I think there were five—were the figures of men conspicuous for their bravery in the long-past history of the empire. The Chinese do not believe the images to be these men themselves, but likenesses of them; nevertheless the dead men's spirits are near, and as the tea evaporates from the little cups which the devout place before the statues, they say that the spirits are drinking up the liquid. How they explain the solid residue I did not learn. The carving of the altar on which these heroes sit is exceedingly intricate and deep, and richly coloured. A sacred light was burning on it, and is never allowed to go out. They imagine that this light keeps away the evil spirits, which correspond apparently to our devils in their love for darkness, and in their powers of annoying and hurting mankind both before and after death.

I learnt also that the Chinese believe in the Creator and Sustainer of the Universe, and also that from Him come all good things, but they picture Him as too remote to concern himself with individual men, and as they have nothing to fear from Him, they pay Him but little worship. It is the terror of the devil and his legions which greatly influences their thoughts and lives, and at times they beat their tom-toms and clash their cymbals to frighten these physically timid powers of darkness away. A notice on the wall stated that all visitors must pay ten cents towards the

Joss House ; we did not do so, but perhaps the price of the fire sticks of scented wood which we bought for a trifling sum on the assurance that their pleasant scent was both a preventive and a cure for noxious insects in luggage, was accepted instead of the unpaid donation. My guide informed me that visitors are not always allowed to see the interiors of these houses of worship.

After paying for a seat at the ticket office, and mounting some stairs, I next found myself seated in a wooden rickety chair, with a few other visitors, on the stage of a Chinese theatre, in the thick of a play which had begun about four in the afternoon, had continued without stopping since then, and would not end much before midnight. The general arrangement of the house itself was much the same as that of any other, and from floor to roof it was filled with Chinamen, except one gallery, well screened off, which held, I believe, the Chinese ladies. There was but little talking : every one seemed interested in the play, except a few ragged children who were running about, some on the stage near us, and some behind it. A few of the men were smoking, including some of the actors not, for the time, taking part in the scene. About a dozen musicians filled the back of the stage, and were playing continuously, except during the comparatively rare intervals of *spoken* dialogue on the part of the actors. Their music was exceedingly interesting, in spite of its monotony. It was all minor ; the air, repeated with little or no variation, being neither sad nor merry, reminding one distantly of some brisk Irish melody. It

contained, I think, a subject and answer, each expressed in a few phrases, and written in a mode to which our minor seemed the nearest approach, but different from it in a way I could not grasp, though I tried hard. A single violin led; there was no proper alto or tenor part, but a weird accompaniment, made by striking sticks of different lengths, which emit short sounds of determinate and high pitch; and by a sort of kettle-drum, a triangle, and a pair of large brass cymbals. These last were not used all through, but to emphasise some specially interesting part of the dialogue, or at the close of what perhaps corresponds to an act.

The scenery is the same throughout, namely the stage itself, and the curtains at the back of it. The accessories were few: a table, and a highly ornamented arched window on legs, reminding one of the front of a "Punch" show, through which the man actor at one part of the play, watched the gestures of the two women talking together, and overheard something which made him clap his hands and give vent to other expressions of joy. As to the subject of the play so far as I saw it, I could only guess, scarcely knowing a word of Chinese, but it seemed that the hero had taken a violent fancy to an exceedingly shy young woman, who had to be won over by a person who was either the wife, or at all events an intimate friend, of the man. *He* sat quietly at the side of the stage doing nothing, whilst his ally sang his praises in a high and rather harsh voice, following only to a very moderate extent the music of the orchestra; but

even after a couple of hours of this curious love-making by proxy, the girl could scarcely be induced to sit for a moment on the far end of the couch on which her lover was seated, and matters were not looking any better for him when I left. The Chinese do not allow any women to act on the stage, and the two I have mentioned were in reality men, but their disguise was, to my eyes, perfect. The feet would of course be the difficulty, but their dresses were long, and only the toe of a shoe peeped out now and then. Both of them had fans, and the shy girl only rarely ventured to peep over the top of hers; the other used hers much as her European sisters do. The audience evidently followed everything very closely, and now and then interrupted this very even performance, with roars of laughter. Everywhere I saw intelligent and beaming faces; cups of tea were passed round at intervals, and in spite of the length of the performance no one looked sleepy or yawned.

Leaving the theatre, I visited a large clubhouse, and much enjoyed a cup of tea myself, served in Chinese fashion. Then we returned to the hotel by a circuitous route through back streets (which in some respects bear a strong resemblance to ancient Pompeii), calling at a Chinese bazaar, full of such beautiful and interesting wares, and so cheap withal, that they and the blandishments of the vendors proved altogether too much for me, and I made several purchases—Chinese ink, chess-men, paper-knives, stamp boxes, handkerchiefs, a gong, two tea sets, and other things which in New York I believe

cost at least three times, and in England ten times as much, or even more. The inscrutable Chinamen became evidently interested as the number of purchases became greater, and finally made me a present of a box of Lychees, pretty-looking brown nuts, with a fruit inside containing a stone, and tasting rather like a raisin. They packed all my goods, and bestowed them in the hotel that night, ready for our departure, which took place early next morning.





CHAPTER VI



ONCE more we passed across the bay, the sunbeams dancing on its busy waters, and in a few hours' time were climbing the steep slopes of the Sierras under mile after mile of snow-sheds; in fact, for more than sixty miles the rails ran under a long, unbroken tunnel. One side is generally rock, the other a forest of massive hewn timber supports, which fly by so quickly that they produce all sorts of queer effects: sometimes through holes in the boarded walls glimpses of the scenery can be caught, but often it is almost pitch-dark, and the traveller wishes that the masters of the Rio Grande had seen their way to make a summer track, as the Canadian and Pacific authorities have done. The great strength of the construction bears witness to the weight of the snow in winter time, and for the difficulties which the engineers must have had to encounter who constructed these wonderful links between east and west.

Thunderstorms were brooding over the land we were leaving behind us towards sunset, and again I saw the tall cumulus clouds, which seem to accompany electrical disturbances in this part of the world. It grew quite cold, and a snow-storm would not have been a surprise when we stepped down from the train and made a rush for food at a small station. Next day found us in the desert, though, as the line follows the course of one of the few rivers—the Humboldt—it did not look so thirsty as one might expect; besides, there had been heavy rain, a great blessing, and when the heat of the day came on, we could open the windows without fear of being choked by the fine sand and dust, which so often make this part of the journey anything but pleasant. If all is dry, and there is wind, the dust finds its way through every chink and crevice of the car, and the inmates sit, hot, choked, and miserable, even with fruit and iced water to help them to while away the time. We experienced nothing of this sort; a cool breeze blew, and the fascinations of the ever-changing diorama of gently sloping plains and bold mountain ranges kept us busy watching hour after hour (Plate XXXV.).

The terraces on the lower slopes of these hills show plainly that once all this country was under water, and any one who can at all read the face of the land feels no surprise when in the afternoon he sees, as we did, in the distance a long thin, perfectly level white streak, telling unmistakably¹ that the waters of the Great Salt Lake

¹ As a matter of fact, we thought we saw the lake several times before we really did so—the hot layer of air next the



are at last in sight. For miles we traverse its flat, cracked, muddy shores, almost bare of vegetation; what little there is, grey and withered-looking, the leaden waters lie far away. Here and there thin, white, glistening incrustations of salt relieve the monotony of the dull and lifeless waste; or the train rushes past half-dried swamps, with a few sad-looking rushes skirting their edge. Towards evening the sun warms into purple the distant lofty mountains, and kindles a golden path on these mournful waters; and so we bid them farewell for a time. The scenery changes, fields take the place of the vast stretches of ancient sea-bed, cottages and trees appear once more, and, as night closes in, lights sparkle like glow-worms in the darkness; the train draws up in a crowded station; we have arrived at Salt Lake City.

Here we should have stayed longer if we had had the time to spare, and tried to learn on the spot something of the life and conditions which prevail amongst the Mormons; as it was, I heard some warm discussions in the train, and had some interesting conversation with a man who, though not a Mormon himself, had lived for more than six years amongst them. To put down very

ground reflecting the lighter-coloured sky near the horizon behind it, and the spurs of the mountains running down into it, so as to give exactly the appearance of a large lake in the distance. That this was only mirage was abundantly proved by the change wrought when the railway ascended a few feet. This had the effect of making what had looked like a number of little islands into one long dry promontory, and shifted the shore of the mirage-sea to a much greater distance than before.

briefly some of the points :—The women, my informants told me, are stronger advocates of polygamy than the men. I asked if this was caused by undue influence of their husbands ; they said no, not at all. The men are exceedingly proud of the Mormon faith, and often let every one know that they are members of the society without being asked. They genuinely believe in the book of Mormon. Having read the book myself, I asked how this was possible, and was told that most of the Prophet's followers were almost destitute when they came to Salt Lake. Young gave them land, money, a fresh start in life. Is it wonderful that they should place implicit confidence in the man who has done more for them, practically, than any one else, and trust him in matters religious, as they have reason to do in matters secular ? I understood that Mormonism and polygamy are quite apart ; the revelation of the "will of God" in the latter, came apparently only to confirm and ratify what was already the way of life of some of the Mormons.

The city flourishes, there is no doubt of that ; the Gentile element increases year by year, but the "Elect" hold their own at present. It is still unsafe, so I was told, for an inhabitant of Salt Lake City to differ publicly in opinion from the teachings of the Mormon priests ; but the terror of the ever-watchful Mormon eye is not so great as it used to be. The railway has made the means of escape much easier ; and, perhaps even the members of the Vigilance Committee, if it still exists, have now some respect for the civil

law, and for the general interest which a mysterious disappearance will excite, if by chance it should get into the daily papers. Polygamy is civilly criminal, but the judges who try cases in Salt Lake are appointed by local authority ; and this diminishes the number of complaints to a very low figure, and tempers the severity of the sentence, if one is ever pronounced.

All agreed that few men have possessed such absolute power, or wielded it more despotically than Brigham Young. At a certain period when Gentiles were invading the New Jerusalem, Young thought it high time to know definitely who were of the faith and who not. He therefore, in a speech or sermon, told his audience that all his true friends were to get their garden gates painted green by such and such a day, and, said the narrator, by that morning there was not a single gate to be found that had not been so painted. Whether these assertions are true or not I do not pretend to judge ; I only state what I heard as I heard it.

To turn to another matter : the waters of the Great Salt Lake are not lifeless, after all : they contain innumerable specimens of some microscopically small but living being, the only survival, probably, of the many forms of life which once filled the immense inland sea, whose waters stretched for three hundred miles or more in all directions. The intensely salt waters of the present lake have a very energetic effect on the skin of bathers, and affect the eyes painfully, producing soreness and swelling, so that it is well to take care not to let the brine touch any part of

the face. Common salt is by far the largest constituent, but, as in sea water, there are also compounds of magnesium, though not in so large a proportion.

After leaving the city, the railway runs through mountainous country; we could, however, see little of it at night, though there was a moon, and by the time I was in a state to notice anything next morning it was broad daylight, and we were turning out to breakfast at Glenwood Springs, Colorado, a very unfinished-looking place, with a fine hotel out of all proportion to any of the other buildings, and a bridge of which I should think the engineer feels proud. The journey from here to Colorado Springs is through really magnificent cañon scenery. It would be difficult to exaggerate the grandeur of the great rock walls between which for a long distance the river and railroad wind their way. In one place there is not room for them side by side, and the railway is carried by a wooden parapet built out from the face of the perpendicular cliff, with the muddy waters flowing close beneath. Often you cannot see the sky at all without putting your head outside the window and then looking up vertically—a position it is not easy or desirable to maintain for long; and so deep and narrow is this Royal Gorge, that it is gloomy on the brightest day. Gradually the panting engines climb the slope, the cañon walls grow lower and lower, the valley opens out, and frequent mining sheds and tunnels impress upon you the fact that you are in a rich metal-bearing district.

At one point, from a break in the cañon's side, °

a stream of lava has flowed, and its rugged, black cindery prominences and hollows are yet too little weathered for vegetation to grow on them. So far as appearance goes the eruption might have happened only a few years ago, but in such a rainless tract as this the time necessary for the fertilising of a lava stream is no doubt very much longer than in moister climates. Even in Teneriffe, which enjoys a considerable rainfall, lava streams a century old, such as those near Guimar, are almost as bare and savage as they were when first they cooled. Only one kind of bush has as yet taken root on the stream which overwhelmed Garachico, years before the great gap of Pedro Gil,—the source of the Guimar lava,—was formed in the splendid crater wall of the Cañadas.

All the way through the Royal Gorge the scenery has been built of granite, but as we near Pueblo one beautiful woodland river picture after another flits by the carriage window, and in the distance, over the wavy lines of intermediate hills and mountains, Pike's Peak can be distinctly seen. A grand yellow sunset, with torn clouds, lit up the prairie as we came out upon it, and before the light had altogether faded, Colorado Springs, our terminus for the present, hove in sight, and we spent the rest of the evening enjoying the comfort of the Antlers' Hotel, and the excellent music provided for the entertainment of its many guests.

Next day broke grey, cold, and windy. We were driving in a "Surrey" with a pair of black horses, towards the "Garden of the Gods," when

a rotten pole-strap gave way, the pole fell, the near horse all but came to grief over it, and in saving himself burst collar and bearing-rein. There the mischief ended; we got out, and passed the time gathering flowers and watching some rifle practice going on at the butts, whilst the driver, after a little temporary mending, went back to the hotel to get some stronger harness. After his reappearance, a few minutes brought us in sight of the extraordinary rocks which, I suppose, gave the name to this widely known spot.

Imagine an undulating, wooded, hilly country, sloping down to a level plain. Just where the hills and plain meet, there rise, as though they had been pushed up suddenly from below, and had nothing whatever to do with their present surroundings, a long line of most aggressively red, almost vermilion cliffs. This line is broken in places, but can be followed by the eye for many miles along the foot of the Pike's Peak satellites, and wherever it appears the scenery is, to say the least, very unusual. In spite of their great height—and I should think many of them attain two or three hundred feet—these cliffs are most surprisingly thin, and fill one with still greater astonishment when seen endways on (Plate XXXVI.). They appear to consist of a kind of sandstone, which in a moister air would most likely have perished quickly; as it is, the weather has worn them into grotesque shapes. From the point where the two main groups of these strange rocks are seen, one in General Palmer's very pretty garden, and the other some distance to the left, many of them look like



queer images of gods rising out of the earth. Others resemble camels and birds ; there are two seals on the sky-line of one of the rocks, remarkably well carved by Nature's own hand. One almost wishes that the coachman would not insist in pointing out and naming these chance effigies ; they are so plain that he must be indeed devoid of imagination who does not see them for himself—and a hundred others, too, which have not been named. Further on we passed a huge boulder—of the same red substance—resting on a very small area. Often the forms of the rocks made me think of the Parson and Clerk, and other yearly disappearing landmarks on the coast between Star Cross and Teignmouth, in South Devon ; and from the similarity of colouring and weathering, I imagine the nature of the rocks is very similar. We passed some "Mushroom" formations, too, but none to compare in beauty with those in Monument Park, described a little further on.

We were now rapidly nearing the mountains, with the great Peak overtopping them all ; and, after a short piece of downhill road, reached the little town of Manitou, and stopped first at the Soda Spring. Its cold water gives off carbonic acid gas copiously on rising, and has a rather pleasant taste. In a shop close by is a fine collection of minerals found in the neighbourhood—agates, green felspars, endless specimens of quartz, green, purple, and colourless ; iron pyrites, realgar and orpiment, crocidolite, azurite, malachite, and many others, both interesting and often very beautiful. We made a limited selection of

these, and then trudged to the Pike's Peak station, and took our seats in the car for the summit, over 14,000 feet above sea-level, but only 8,000 above the prairie plains. To travel the eight miles from Manitou to the top takes about an hour, and the transition to the rarer air is so rapid that almost every one is much more aware of the difference than he would be if he had taken the usual twelve hours allowed for the ascent on foot. Some feel a slight pain in the region of the lungs, others are sick and giddy, and all, so far as I could judge, disinclined to exert themselves. By those accustomed to the temperature of the plains, the cold of the summit is keenly felt. Many seemed to have had no idea of how much colder it would naturally be up here, and shivered about the stove in the house which crowns the Peak, audibly wishing they had brought great-coats, or their feminine equivalent, whilst snow was falling outside.

The day was cloudy, and though the nearer views on the way up were good, a dense mist covered the summit, and the prospect was consequently a perfect and absolute blank. This did not tend to raise the visitors' spirits. They clustered round a bar-like counter, sitting on high stools, and eating lunch, and were evidently pleased when the time came for going down again. Soon after three o'clock every one had gone except ourselves. The evening brought no change in the weather, but the wind rose, and sleet drove hard against the window-panes. We passed the time in base luxury, from a mountaineer's point of view, sitting by a roaring stove,

and talking of Cripple Creek and fickle fortune with the summer inmates of this mountain hotel, one of whom at least knows by experience the excitements and disappointments of gold digging. About ten I went to bed, but not to sleep ; the howling and roaring of the wind, and the creaking of the many doors, and perhaps the effect of the lighter air, kept me awake hour after hour, till about 5 a.m., when the voice of one of the men outside told me that it was still misty, and that it would be a mistake to get up to see the sunrise. Though it may be hard to believe, I submitted to remain where I was without a murmur, and instantly fell sound asleep, to be awakened at once, it seemed, by the same voice, with the news that the fog had disappeared and that the view was unusually clear.

In twenty minutes' time I was photographing right and left with yellow screens and isochromatic plates, and hope that the results may show friends at home what some parts, at least, of the marvellous panorama are like.

The summit of the Peak is so broad that from any one spot only a small fraction of the whole view can be seen. The slopes of the mountain itself, and the many lower hills near it, always form the foreground, but less looking towards Colorado Springs than on any other side. The town itself looks like a little vegetable garden, laid out in neat little squares, with narrow white paths between, the distance being too great for the unassisted eye to distinguish separate houses (Plate XXXVII.). Beyond the Springs, the prairie stretches out like a sea, becoming bluer and bluer,

till it ends in so even and flat a horizon line, that a hasty observer might well think it the ocean itself. Faintest grey in the far south—nearly two hundred miles distant—is the long low ridge of Fisher's Peak ; fifty miles nearer, Spanish Peak, a shade darker, but still only to be seen by careful search. Wisps of smoke cloud alone reveal the cities and villages, just awakening to another day of their busy life. West and north lie range upon range of hill and mountain, variegated with the deep blue velvet of distant wood or flitting cloud shadow, till all the country seems an ocean whose mighty waves have been enchanted by some song of heaven, and stand still evermore to listen, No view from any mountain-top I know quite equals that from El Teide of Teneriffe, but here the prairie sea almost makes up for the lack of the true ocean meadows, and the distant peaks extend the possibilities of sight far beyond what would be its limits were there plains on every side alike, at the same high level as these.

Outside the hotel is a large thermometer. The men told me that its readings were once noted regularly, but as no one ever paid any attention to the notes, the observations have been discontinued. It surprised me a good deal that the opportunities this Peak presents to the astronomer and physicist were not made use of—and in America, too ! What would not some of us give to have this one mountain in the Old Country ! I suppose the day will come when, as from the Lick telescope on Mount Hamilton, and from Mr. Lowell's in Arizona, from Pike's Peak also will come the latest news the light from sun and star



and planet has to tell. The anemometer would have a fine chance of making a record up here, if what I hear is true, that sometimes the wind attains the truly fearful speed of 162 miles an hour! And a hurricane is only ninety! No wonder the walls of the house are three feet thick, and that great pains have been taken to make the foundations secure. The cog-wheel cars are comfortable enough in quiet weather, but the people in them must have an exciting time when they arrive at Windy Corner on a rough day.

Before noon the first train arrived. From the remarks I overheard, the excursionists seemed greatly to enjoy the sights. Almost every one of them sent a telegram to some friend, answer prepaid—partly, I think, because this house is the highest telegraph office in the world, and partly as a sort of souvenir. After registering our names in the visitors' book, we began the return journey. The engine went first, and slowly let us down. On the step outside, a grey and elderly man amused himself, and apparently a few of the passengers, by aiming at anything which happened to attract his attention, from a small wild bird to a large leaf or a stone, with an air-gun. I am not certain whether he was not trying to go as near as he could to the objects, whether living or inanimate, without actually hitting them. If so, he was a good shot, and a humane man—but this does not explain the hilarity of some of the passengers.

The lake and woods seemed to be rising up to meet us, rather than we descending to them. In places the banks along the side of the car-way

were all ablaze with dark purple and golden-eyed Michaelmas daisies, or with clusters of sunflowers. About one o'clock we were once more in Manitou, and looking back to the far-away summit and the little speck of a house we shall always remember with pleasure.

That afternoon we drove through Ute (pronounced "eut") Pass to Cascade cañon. The entrance to the cañon is a fine piece of rock scenery, but after passing it, the drive is rather uninteresting as far as the dangerous level-crossing, with its most sensible warning board and bell. Then it grows prettier, and the little cañon itself quite repays a visit. It is a narrow and steep gorge, with a stream flowing through the shady woods in a series of small cascades, very much like the Torc Waterfalls near the Middle Lake, Killarney. It is well that we visited it before seeing the two Chëyenne ("shyén") cañons, or even Williams'; these, though it would be a mistake to compare valleys so different, are much more impressive, and, I think, should be left till last. On our return to Manitou we found the road blocked with people and horses, and witnessed a rough race of the latter along the high-road. The car back to the Springs was crammed with passengers to a perfectly ludicrous extent. They were hanging on like bats to the posts which support the roof, all very cheerful and none the worse for their holiday, which they call, curiously enough, "Labour Day."



CHAPTER VII



THE Garden of the Gods had disappointed me in one respect. For many years I believed that in it are to be found some of the finest specimens of earth pillars, objects which are among the most curious results of the action of rain and streams on a particular arrangement of soil. In fact it was chiefly to see these that I had come to Colorado, for well-developed instances of them are exceedingly rare, and with the exception of those in the Austrian Tyrol, I had never heard of any other very fine ones. It is true that near the balanced boulder, there are in the Garden of the Gods some low mushroom formations, as they call them there; but these are very poor compared with the pictures of the earth pillars in books on geology.

It was only after asking most persistent questions, I found out that a district called "Monument Park" was likely to satisfy my curiosity, so we determined to spend next day

there, and began by driving some miles along the white and dusty Denver road. Before actually reaching the Park, a lofty white pedestal on the right, capped by a flat red stone very much like a college cap, told me that my wishes were to be fulfilled, and in a very short time the camera was at work again, photographing this splendid pillar, with Pike's Peak for background (Plate XXXVIII.). There are two or three more, quite close, on the top and by the side of the low hill, and the smaller ones illustrate admirably the way in which these curious and most striking objects are formed. Later in the day we passed hundreds of them, but none finer than the first one.

To explain them roughly is easy. A hard, flat, and thin stratum of rock, which cracks, but is not worn away fast by water, rests on some softer soil. Rain falls, sinks through the cracks in the upper, hard layer, and hollows out the soil below, first by its dissolving action, and then, when outlets for the tiny underground streams have been found in the face of a cliff, by mechanically wearing it away in narrow, ruts with almost vertical sides, ever growing deeper and dividing the ground into columnar structures, each with its hard cap of the top soil (Plate XXXIX.). Meanwhile this top soil is itself affected by the rain, the expansion and contraction caused by summer and winter, or by the hot days and cold nights. Sometimes it is split by the freezing of moisture in its pores, and so it falls, little by little, into the miniature cañons, in fragments to be gradually dissolved or swept away by the trick-



Earth Filler and Filler, Filler, Colorado



Fig. 1. Mammalian skull.

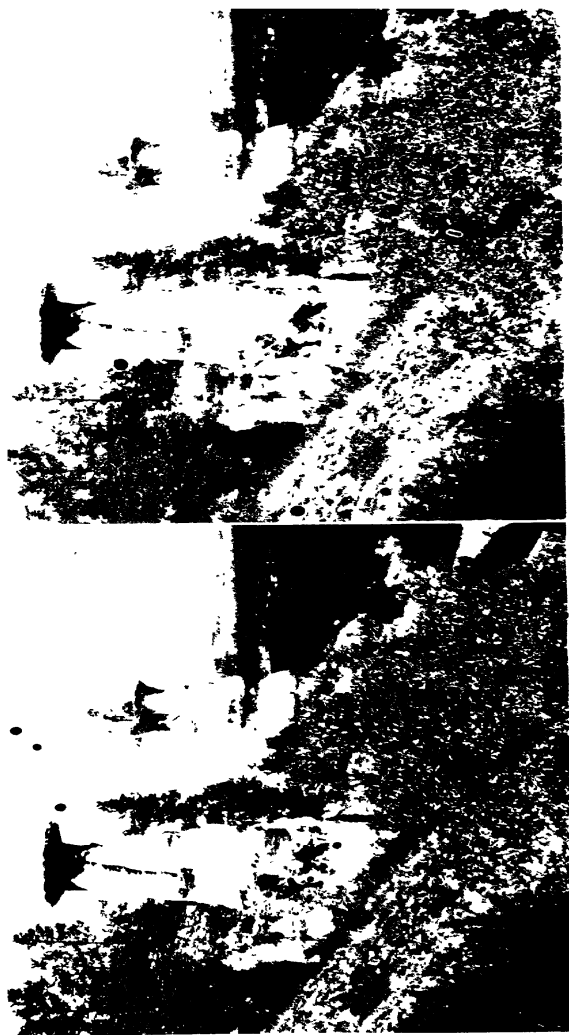
ling water ; except where it rests securely on the pedestals of softer soil below, and there it is left, high and dry, partly protecting the pillar beneath it from the direct action of rain (Plate XXXIX.). But in time wind and moisture triumph. The supporting column grows thin in places ; the rock cap, no longer level, slants more and more towards the side on which the weather takes most effect, until it falls. Sometimes its thin neck breaks, or the wind lifts off the loosened cap ; and along the old river cliffs in Monument Park hundreds of these strange figures may be seen, in all the stages of their long life, from the sturdy young earth pillar, just born from the retiring cliff—short, thick, and with a large and new-looking cap level set—to the tall, gaunt giant with spindle neck, nodding with age and infirmity ; or the last stage of all, without cap, or neck, or waist, or anything—a mere low, shapeless lump of the softer soil.

It gives one a strange, eerie feeling to come upon a group of these white figures, on the borders of the wooded cliffs, standing round and apparently discussing some dry topic in their unheard and unknown language. One can almost tell from the slant of their caps their several characters and sentiments. Here are to be found, frozen to stone during the day, but surely alive and moving when no one is looking, the White King and Queen from far-famed Alice's Wonderland and Looking-glass country ! Here are the Pawns, and the Duchess, and the White Rabbit ! And surely, between the trunks of the pines in that "tulgey" wood, one can see

something that can be none other than the dread "Bandersnatch" itself!

I do not think people know what they miss in leaving Colorado without seeing Monument Park. My driver said that hardly any one ever came here—I suppose because they never hear of it; and the photographs I afterwards found in one or two hotels are not by any means flattering; so much in a landscape depends on colour as well as form, to say nothing of stereoscopic effect, and, possibly, motion. Every one should see the "Quakers," and the beautiful groups which lie on its right side as you drive from the farmhouse near the "Quakers" towards the mountainous side of the Park. Do not be content with the view from the carriage; you must wander all about them before you can possibly form a true opinion of their beauty (Plate XL.).

The caps of these pillars seem to be made of a dark red sandstone, the bodies of conglomerate, as if a coarse granite had been disintegrated by water, and then the quartz lumps cemented together with the clay derived from felspar. At a moderate distance the lines of horizontal strata in which this soil has been deposited are clearly visible, both in the pillar structures and on the main cliff; but in two or three instances in the first group you meet after passing the farmhouse alluded to, there are also some slanting, slightly projecting ribs of apparently harder material, which I cannot explain, except by supposing that they mark the course of veins of matter forced up into the *already stratified* material of which the pillars are mainly composed. These lines cut



Scene at Memorial Park - C. J. de Spino.

the horizontal layers, which are quite distinct, at a very considerable angle—say 45° . I hope both sets of lines will be visible in the stereoscopic photographs (Plate XLI.) I took of these particular pillars, which, taken as a group, I thought the most beautiful of all. They are about twenty feet high, and lie within a hundred feet of the road.

The trail leading out of the Park is in a very bad state, but it runs through a peaceful and happy-looking valley, and our slow pace only gave us the more time to enjoy it. The frequent gates are rather a hindrance to progress all through, but when the last is left behind you drive lightly over the springy grass, and on every side there are prairie dogs sitting up, watching, or scampering off to their burrows.

It was a lovely evening, calm and brilliantly clear; the sun set in a bright white sky behind the mountains, whilst all the *eastern* heavens flushed orange and pink, and it was nearly dark before we regained our hotel. After dark the waterworks were turned on to flood the meadow at the back of the house. When the moon rose it shone through the trees, and, with the many lighted windows, made lovely reflections in the still water, whilst the strains of the string band left nothing wanting to make the evening repose and pipe enjoyable. I am bound to say the summer nights seem to me shorter in America than even in Norway. No sooner is one asleep than it is time to be getting up; the ruthless knock at the door leaves no possibility of doubt—though it is very pleasant to feel that you can

depend on being called exactly at the hour you wish. How many countries might learn a lesson from the States in this respect! And what a difference all day is made by an early start, especially in hot climates!

We intended to see the Seven Lakes, and were told over-night that a start must be made soon after seven in the morning; and at seven precisely we jumped into our "Surrey," and in the delightfully fresh morning air jogged slowly along towards the mountains. Then the ascent began through Bear Creek Cañon, and continued for about six hours; the horses simply crawled the whole time, stopping to rest every dozen paces. Probably this slow pace is necessary, as no change of horses can be had, even though each halt allowed the sun to climb a little higher and reduced the chances of any shade later on; but it was certainly rather trying to patience. For part of the way the dust was also choking. At last we looked down on Loch Marie, which is often spoken of as one of the Seven Lakes. This is untrue; the Seven Lakes are not reached till you have crossed the watershed, and if the hint may be given without offending anybody, it is well to make it thoroughly understood before starting that you wish to see the first three or four of the Seven Lakes, and not merely to go as far as Loch Marie and then turn back.

The road begins to rise again more steeply as you leave this wild and beautiful sheet of water behind and below you, and the finest part of the whole drive by far is the open mountain scenery between the lake and the highest point. I



Group of Earth Pillars, showing level stratification and slanting sheets of some harder material. The pillars, pulled from the layers of the bottom of one of the pits, are the only ones that were found. They are the only ones that were found. Colorado Springs.

expected to see over the top of the pass the Seven Lakes stretched out, one beyond another, in a long, shallow valley. Our driver's answers to questions as to their whereabouts seemed to me vague, and on asking him how large and what shape they were, how far from one another, whether the fishing was good, and other questions, he became more and more confused in his answers, till I inquired point-blank whether he had ever been on this road before, to which he answered plainly "No." This made it much more interesting for all of us, when, on reaching the watershed, a glance at the valley in front showed nothing large enough to be called a lake, though there certainly was a huge bog just below us. Two trails were also visible, one running to the right along the hills up a side valley to some mines, whilst the main track, after a rather steep descent, ran along this side of the morass and disappeared round a corner.

To see whether the Seven Lakes were in the side valley, I followed the well-beaten trail to the right on foot, and very soon got a clear view right away to the end of it; but no lakes of any description were to be seen. Meanwhile, an army of black clouds was drawing up its forces on the southern slopes of the Peak, and distant thunder announced that the elements were already actively engaged. I hastened back to report to the "Surrey's" occupants the necessity for moving on to some more sheltered spot; but we had not gone far when a cold wind struck us, simultaneously with a grand roar from the clouded skies, and a few large drops of storm-

driven rain. Fortunately some campers' tents stood near, and after asking permission to enter one of the largest of these—a request no sooner made than granted—we had our luncheon-basket transferred to the tent, and began to make merry, sitting on the wooden benches, unpacking the good things and laying them out, after a clearing had been swept on the old table, crowded with all kinds of biscuit boxes, candlesticks, and empty bottles.

Our host had been in this spot all the summer, cooking for a camping-party, and told us there had not been a single warm day for weeks. Heavy hail was rattling on the canvas whilst he was speaking, and the stove hissing and spluttering. The only warmth seemed to be that of our sympathy for the cook. It grew really very cold, and when the hail changed to rain few parts of the tent were free from drips. Water came stealthily in under the canvas, along the ground, so that valuables had to be moved to the islands left. The carriage cushions, which were of a watertight material, proved most handy footstools, and for the time, at all events, I felt no desire whatever to camp out in these high regions.

We gave our friend a cigar and a pear; he seemed particularly pleased with these trifles, saying that he had seen an apple or two that season, but no pears, and as to the cigar—"Ah! we don't get them new things up here!" I think he also appreciated something else of an effervescent nature, which, however cold at the time, kept us warm till the sun came out once more;

and with heartfelt thanks for the shelter and the tea—for amongst the other luxuries we enjoyed was the drinking of *very* strong tea, fresh from the stove, in tin cups—we drove on, and found two or three of the Seven Lakes, shut in between steep wooded slopes, about a mile and a half from our impromptu camp. Three men were encamped on the shore of the first. One of them told us they were fishing, but the sport so far had not been good; and as for the weather, the less said about it the better.

It was too cold, after the warmth of the plains, to enjoy anything much, so we turned our horses homewards. Often glimpses of the great plains in the V-shaped gaps through which the road runs remind one of the blue sea filling in the space between the gentle green slopes of some Cornish valley. And so once more out into the prairie, under the same strange kind of sunset as we had last night, all the *east* flushed with pink, whilst westward the sun sank behind dark indigo mountains, with a bright white, hazy cirrous sky over them.

Next day was our last whole day in Colorado. We had already dedicated it to the two Cheyenne cañons, and after an early breakfast, armed with a hamper full to overflowing (as the salad dressing proved only too literally), with a hot sun behind us, but a deliciously cool breeze blowing from the mountains in our faces, we sped swiftly along the narrow roads to the place in the woods where the ways to the North and South Cañons diverge, and then made for the former. The entrance is grand, and the grandeur lasts for

quite a mile along the road. It seems a pity that one cannot get the first impressions of these gorges by driving down them from their upper ends; then at every turn the rocks' right and left become higher and higher, and the most impressive part of all is seen last; whereas, entering them as we do, the finest part is seen first, and makes the rest seem tame in comparison..

This is especially true of the cañon I am now writing about, and there is little to be gained by following the carriage track further than the place where tourists usually stop. My driver told me there was no place to turn higher up, which proved absolutely untrue. If you wish you can follow the road as far as it goes, and there is an excellent turning-place just where it becomes a mere foot-trail at the foot of a gold mine; the entrance to which is closed by a padlocked door with a bell! In front of this door, and about six paces from it, is a broken-down wire fence, with a wicket to which is attached a notice, written by hand, to the effect that visitors may see the interior of the mine for a small sum—twenty-five cents, I think—but it adds rather curiously, that if you pass the *gate* you have to pay the fee. The rocks and sand about here are full of "fools' gold," a kind of mica, so far as I could make out, with a yellow, lustrous surface, easily splitting into thin plates, and soft and soapy to the touch.

The same red sandstone rocks which form the most striking feature of the Garden of the Gods add their gorgeous colouring to the mouth of this cañon; they are of a rather deeper shade, and browner than in the Garden, but rise much

higher, and are magnificent objects when seen far above the pines which grow thickly in the bottom of the valley. The reds and greens reinforce each other by contrast, and it seems to me that so far as colour goes this Northern Cañon is the finer of the two, but does not approach the Southern in grandeur.

We returned to the fork of the roads, and in a few minutes reached the toll-gate which lies at the entrance of the South Cheyenne. There we parted with a dollar apiece, an entrance fee which does not seem at all excessive when you have left the gate behind you and are driving or walking (for we found the roof of the "Surrey" shut out far too much of the view) along the road which winds by the stream up this superb cañon. It is exceedingly narrow, and shut in on both sides by stupendous precipices of savage rock. On the floor of the cañon grow some very fine pines, and behind and above these the walls rise so perpendicularly that it is break-neck work to gaze at their summits for long. We walked in deep shade, astonished at the grandeur of it all, even after the many splendid sights we had seen, whilst the hollow murmurs of the stream echoed from side to side.

They say this spot is wonderfully beautiful by moonlight; and no doubt it is so, and if we had had time we should not have left it without a nocturnal visit. Here, as in all other grand and narrow cañons, the photographer is completely foiled, and I might add, the artist also; the precipices are far too high and too near to be represented in a picture. Of course views can be

taken looking straight up and down the stream, but these, fine though they may be, fail to give any idea of the profound impression the near view of the cliffs never fails to produce. Even in Norway comparatively few are the precipices so naked as these; perhaps those most similar are to be found in the recesses of the Upper Aurlandsfjord, that very fine but comparatively seldom seen branch of the Aurlandsfjord which lies on your right as you come out of the far-famed Naerofjord.

We lunched in the large summer-house on the right of the road, and I photographed the "chipmunks" whilst they shyly nibbled bits of bread and cake thrown out for them on to the slopes of coarse scree fallen from the cañon side [Plate XLII.] The old chipmunks were very fat, the young very lean, but beautifully coloured. A table, however rough, would have been a welcome addition to the fixed forms, the sole furniture in this shelter, which must be grateful indeed to the traveller, should wet weather come on. Meantime the cañon resounded with the shrieks and cries of a number of school-children, who appeared fairly to revel in the extra noise the nature of their surroundings made them able to raise. If the voices had been only rather fainter and less full of pleasure, I could easily have imagined that they were the "thin, shrill screams" of some long procession of spirits, driven through the mournful passage leading to Orcus by the compelling Messenger of the Gods; for the sunlight had faded out of heaven, and under a canopy of cloud the walls



Chupicuaro Squamoid. Photographed in South Chavonne Canon, Pecos Peak, Colorado.

looked gloomy, cold, and stern, as any of Doré's pictures of the Inferno.

The gorge turns to the right soon after passing our picnicking spot, and on rounding the corner one is surprised to find how short the cañon is. It ends in a small basin, completely shut in with high precipices. On the right, as you enter, a stream plunges in seven successive stages down the grim water-worn wall ; only the last three of the seven are visible from the bottom of the cañon, but on the left of these as you look at them, a steep zig-zag of substantial ladders, resting on strong supports, firmly fixed into the almost perpendicular cliff, makes it possible and easy for any one to ascend past all the cascades, and to get a grand view of the *cul-de-sac* from above. At the top you are in an open valley, prettily wooded, and the flowers and shrubs by the side of the gentle stream form many small and exquisite pictures. Further on, there are gold mines, but we did not travel far. On the way back we made a halt for photographic purposes, and after regaining our carriage, drove back to the Springs by the road which leads past the Casino, and affords lovely views of the prairie and of the Pike's Peak Mountains.

At dinner, some printed notices laid by our plates reminded us that the kinematoscope was at work in the town, showing in several separate scenes the fight between Fitz-Simmons and Corbett. Wishing to see how such exhibitions in America compared with those at home, I took a seat, perhaps rather too near the screen, and witnessed the struggle between the two athletes.

The flicker was unpleasant throughout, which means that somehow or other more pictures should be thrown on the screen per second ; and what is more trying to the eyes is the want of correct "register" in successive views, which causes the whole view on the screen to wobble up and down through a small distance, perhaps two or three inches. This often made it impossible to follow any rapid action, and I should think might be partly due to the nature of the film on which the pictures are taken. On the whole, I do not think this particular show was nearly so good as the "Biograph" entertainment in London.

One thing interested me a good deal. I noticed that a man sitting next to me viewed the pictures through two small holes, cut out in a sheet of dark-coloured paper. He told me it notably lessened the flicker. I tried the plan, and found it work, as my informant said: but it cut off too much light to my mind, so I did not use it long. Several of the scenes which happened just after the wrestling were shown. A man passing in the foreground looked up for an instant towards the audience with a tragically woe-begone expression, whilst the conductor or expositor, whichever he should be called—simply remarked, "That is Mr. So-and-so; he has just lost 70,000 dollars!" Perhaps that is not the exact sum mentioned; in any case it was large enough to provoke most unfeeling mirth on the part of the spectators.



CHAPTER VIII



Our train for the East was not due to leave the Springs till the evening, and we did not wish to lose any chance of seeing more of this wonderful region, to which I found we grew more attached every day. that we stayed in it, we spent the morning next day in Williams' Cañon. Whilst it is not nearly so grand as the South Cheyenne, the entrance is the narrowest I have seen, and is only an inch or two wider than the breast-pole of a "Surrey." The rocks, too, lie in thin strata, almost horizontally, and are often very much undercut, projecting over the road in huge flat slabs. The cliffs of Moher, Co. Clare, or that dark headland of Muckcross, not far from the little-known but exquisite coast under Slieve League, Donegal, are like these, but on a larger scale altogether.

Near the top of the cañon the road crosses the bed of a stream, and winds in long zig-zags up the western side of the cliffs. The first part of the

track lies far below, white and narrow, and over the cañon appears the endless prairie. We stop for a moment at the Cave of the Winds, and then proceed by a footpath for a few minutes across the ridge dividing Williams' Cañon from the Ute Pass: a magnificent panorama of the Peak and its attendant mountains, all bathed in sunshine, opens in front; and when a carriage-road takes the place of the foot-trail, there will not be a finer drive than up the one cañon and down into the other, and through it home again; and the Caves to be seen on the way will add to the attraction. I hope this road will soon be made; it will not be a very difficult task, so far as I can judge.

After descending a few steps, the little wooden house in front of the Manitou Grand Cavern lies before us: the guide lights two paraffin lamps, hands one to me, and with the other leads down a long, cool passage, stopping now and then to point out curious stalactites. At our special request, he makes straight for the so-called organ, a set of these hanging, brownish-white spindles, high up on the right side of our dark road. Kindling a piece of magnesium ribbon, he holds it up so as to cast the different "pipes" into relief. We can see them all clearly in the cold light. They are close together, the longer ones in the centre of the group; each tapering nearly to a point at the lower end, and joined to a boss of the crystalline limestone formation at the upper. So far they are only a fine group of stalactites—nothing more; but the guide takes a sort of drumstick with a muffled head, and strikes

the organ-pipes in some well-learnt order, and all through the dimly-lit cavern ring soft, bell-like notes, but of a peculiar character, sometimes almost nasal, but impossible to express in words. Thus we heard "Rousseau's Dream," and other airs, ending with "God save the Queen"—the tune of which, curiously enough, as learned at one of the late Sir F. Gore-Ouseley's lectures given in the Sheldonian Theatre at Oxford, was composed (as it should have been) by a veritable "John Bull."

I find that considerably more than a complete octave of each of the diatonic scales of C and F can be elicited from this wonderful, natural musical instrument. I heard both of these scales played, and can vouch for the truth of the statement. The intervals are not accurate, and in some cases the curious overtones of which each resultant sound is composed, make it a little difficult to hear the actual note intended, but there is no difficulty in recognising any tune in the least degree familiar. I asked the performer whether he got more than one note out of a single pipe, thinking it likely that a tube, if hit near the free end, would give a sound much below that which you would hear most plainly if it were hit nearer its root, and I found that he did use some of the pipes in this way; but the true marvel of such an instrument lies in the immense *improbability* of a chance arrangement of deposit from hanging drops of hard water yielding rods of such length and thickness as to give the succession of notes actually found here. In the Gough's Caverns at Cheddar, in Somerset, to

my mind the finest to be seen in the Old Country, there are three stalactites next each other in one place, which give the common chord (I forget in what key), but I have never heard of any fortuitous result of the kind to compare with this grand organ, which must rank as one of the musical wonders of the world. I asked whether any of the stalactites had been artificially shortened to raise the pitch of their notes, and was assured that nothing of the kind had ever been done; that one or two had been broken off short by too rough handling, my guide admitted, but declared that otherwise they were just as nature made them. After listening again to the scales played up and down, and with their soft liquid notes still ringing in our ears, we came out into the blinding daylight again, and drove back to the Springs, through the Garden of the Gods, frequently stopping to photograph.

It was a glorious day, and the monstrous rocks of the Garden looked more impressive than ever. If we had only had time, and Colonel Palmer had been at home, I should have liked to inspect the little cañon behind his house, where perhaps lurk unsuspected wonders. As things were, our last natural curiosity was a dyke of gypsum, some of it finely crystallised in fragments of what is popularly called satin spar. But even whilst looking for specimens of this, thoughts of packing would intrude; and so it turned out that, thanks to the excellent electric car service, it was but little past six when Antlers' received us, and from then till we left we were both engaged in the indescribably exasperating process of trying to

get original luggage, *plus* accretions, into the compass of the original packages. But it was done at last, except for the gong and the jar of preserves ; the first was altogether of a different dimension to the available space, and the second had shown already what it would do by way of vengeance if once locked up in a crowded portmanteau.

Soon after eight o'clock, in bright moonlight, we watched the sparkling lights of Colorado Springs, as they grew nearer and nearer together, and fainter and fainter in the rapidly increasing distance ; and, when they had gone, the fast fading outlines of Pike's Peak. So to the last we were reminded of our visits to the different valleys and passes, and felt genuinely sorry to be saying a long "Goodbye" to a district so full of delightful things.

As I write, it seems more like six weeks than six days since we first saw the Peak in the distance, and quite a year from our landing in America. By far the best part of our trip is over. Looking back, it is very hard to say which we have enjoyed most, each place has been so different from the last. Niagara every one talks so much about, that mere curiosity to see if they are right would make one visit it. Then as to Yellowstone Park, there is no other place at all like it in the world ; and so it could not possibly be missed out. Yosemite—the peerless valley—Norwegian scenery may give some idea of it, but then in Norway there are no big trees, and the most vivid picture must fall far short of the grand reality. And lastly, Colorado, perhaps

a little disappointing at first sight, is a place which after even five days' stay it is not pleasant to leave, as we are finding out by experience. For myself, I simply wish I could live in all these places at once—yes, and a thousand more. How soon, alas, the memory of colours fades! How impossible it is to recall those of any scene in detail!—almost harder when looking at a photograph with its one tint, than in the darkness of night, by unaided imagination. This, perhaps, is one reason why the roughest colour-sketch made on the spot gives such satisfaction afterwards. Poor as it is, it helps the weak memory, and brings back to the painter, if to no one else, the reality, and also the true and wholesome sense of how very far he failed to represent it.

But to continue. We are now in Tarry Town, on the Hudson, after three days of uninterrupted travel, the roar of the train not yet out of our heads; very glad, in spite of the comfort of American trains, to think that we have no more of them to look forward to, for it has been exceedingly hot, even for this part of the world. Fortunately we managed to secure beforehand for the whole of the way the privacy of the little compartment which goes by the name of the drawing-room; although, as one of the black servants told me, some prefer the car proper, adding, "The drawing-room's the worst place if anything happens."

Let me draw aside the curtain for a moment: Time about 3 p.m. Position—somewhere west of Kansas City (and in many other places too). Place—the said compartment. Persons—H. and

myself, sitting opposite each other ; H. lies back in the corner of the seat with closed eyes, or looking through, instead of at, a book ; I, with a wet sponge constantly damp forehead, cheeks, hands, and wrists. Four wet towels are suspended by their full length in different parts of the little room. I rise slowly to re-soak one of them, now dry, though thoroughly wetted only twenty minutes ago (twenty seconds, it seems to me). No word is spoken—but much is implied. The towel is rinsed, and brought out dripping with warmish water, and after I have silently applied it to the windows, which dry almost as soon as wetted, it is hung up. A sponge is also useful to sprinkle water over the floor ! I look at the thermometer, dangling by a bit of string from overhead, and remark aloud that it reads 96° instead of 98°, and then sit down and try to read “ Father Stafford ” in a disconnected kind of way : but cannot remember where I left off before wetting the last towel again. Just as I have found the place, the train slackens, and draws up at a station, but the blind is not raised even an inch to look out, for fear of undoing any good the wet towels may have done. Again I rise, and feel the evaporators (!)—two of them dry and stiff already ! Soak them afresh—take a sip of iced water—so does H. The heat seems doubly great in this station ; the woodwork near the windows is almost too hot to touch. Look at thermometer—again 98°—and say, “ Two hours more of this ! ” The big bell of the engine clangs like a tocsin, and off we go, whilst the struggle with the heat begins anew. This continues till near sunset.

I read a sensational article in one of the papers, headed in the usual heavy type, to the effect that an American professor explains the abnormal number of sunspots this year, by supposing that a new planet is about to break off from the sun, and draws a glowing picture of the effects this may have—nay, is even likely to have, on the earth. In our present condition, I could almost believe that his predictions were already beginning to be fulfilled, and wish the train were steady enough to let me steal a look at the sun through the powerful little telescope I carry in a handbag. Later on, during a stop, I get a steady glimpse, by putting a piece of match-smoked glass before the eye-piece, but not a single spot is to be seen; so, if there are any big ones, they must be round the other side, and we still have a few days left! In the smoking-room there are two or three men, more asleep than awake. One of them, however, opens conversation by “guessing” I’m from England, and I reply by some questions on silver as a standard metal. He tells me, “All that’s played out.” I said I understood it was a burning question in America. “Well,” he replied, “it *was*—but it don’t trouble us now.” The others joined in, and, much to my surprise, they seemed to think that things had far better remain as they are, and expressed their conviction that “no one knows what would have happened if the Silverites had had their way.”

Kansas City at last! But what a black, smoky sky! and how intensely stuffy the air is. The sinking sun shows through like a dull red-hot plate. Every one is complaining of the heat.

The thought of staying in the atmosphere inside and near the dépôt for two hours is intolerable. We drive up the steep hill above the station, to a large hotel, and are speedily lifted to the highest storey. With open windows, just a breath of air is to be had ; and so we sit, with a small tea-table between us, till it is time to drive down again. It is a little cooler now, but still a long way over 80° F., and after settling in for the night's journey I open one window. This is a mistake. Whilst sleeping, multitudes of gritty cinders flock into my berth, worse than bread-crumbs. Towards midnight, on waking, the altered colour of what is generally white is quite plain, even by moonlight, and much shaking and smoothing with the hand is necessary before anything like sleep can be had. Even then, it is only broken, and in the grey uncertain light of the dawn, on looking out, I find we are crawling, evidently with extreme caution, over the great Mississippi, into whose waters we look straight down from the car's windows.

What a grand sight this noble river is! We are about midway over now, and the trees and houses on both shores look quite small and dim ; and how the girders of the long bridge creak and groan with the weight of the train ! The oily waters flow beneath the tracks with never a ripple, reflecting the moon clear and round ; and as we near the opposite shore, it is just light enough to see that every tree and stone is mirrored in the sleepy river. The bridge, I afterwards learnt, is one of the finest in America, and more than strong enough to stand any strain to which it is

the least likely to be put ; but just now it is under repair, which fully accounts for the way we crept over it. And so on to St. Louis ; and, after another broiling day, to Cincinnati.

That night, in passing through the Alleghany Mountains, our engines break down, and for a while we make very slow progress. Then, just before coming to one of the many tunnels, the drivers spy some horses on the line ahead. All the noises both they and the engine can make have not the slightest effect. The horses refuse to get out of the way, and of course, if the train starts before they are off the line, they will be driven into the pitch-dark tunnel. To prevent this, two or three of the men alight, and some time passes before the animals are driven to the side.

By morning, the prettiest part of the scenery is past, but there is a cool breeze blowing, and we fly past river and woods. Here some boys are fishing from rocks, which must make the stream quite impossible for any vessel larger than a rowing boat to navigate. There, a group of bathers laugh and shout. Presently country villas crop up on the hillsides ; they thicken and become a city, whilst yonder white and stately dome, rising far above all, proclaims Washington Capitol without need of words. Again I wish for a spare day ; 'all I can do is, regardless of any possible regulations, to swarm up the green embankment which shuts out the view of this marvellously grand and lovely building from the station, and, gazing at its upper parts, supply the rest from memory of photographs and pictures.'

Even this partial view is not to be forgotten quickly. Some day, perhaps, I may see it again with plenty of time to spare ; and also visit the places sacred, not only to the people of the United States, but to all who reverence earnest, resolute men, devoted to the best interests of their country, sometimes at the sacrifice of life itself.

But time is up, and again we speed east, flitting past wide estuaries and low shores. The sky becomes overcast, and, in the double gloom of cloud and twilight, we steam into Jersey City, under heavy thunder-showers. It feels quite cold ; and whilst we wait for the Hudson river train, the heavens are constantly lit up by brilliant flashes of lightning, one every four to six seconds, chiefly white and blue. There is little thunder, showing that the discharges are mostly between cloud and cloud, or spread over wide areas ; but what there is might fitly prelude earth's final scene.

The cars for the Hudson are crowded with interesting and lively people, who seem to think for themselves, and not to allow, as so many in the Old Country do, others to do all the thinking for them. They consequently differ in opinion and practice more than we do amongst ourselves ; and, if it is true that the hope of a race lies in *differences* both between individuals, and in environments which tend to foster these differences, and thereby differentiate one man from another, the States have a bright future before them. From the little I saw and heard they are happily free from institutions which, by a species of mental or physical oppression, turn out sets of

men *all alike*. True progress seems to me bound up with the preservation and practical recognition of the right of private judgment, a right which, although half secured in some countries at the cost of tremendous sacrifice, some men do not appear to appreciate, and make very little effort to preserve from the hands of others, who are anxious, for reasons only to be guessed, to do their thinking for them.

But by this time the train has reached Tarry Town, and in the darkness we drive up the steep hill to the Mot House. The absolute quiet of this peaceful spot is very delightful after our days of travelling; which, I suppose, seem longer to a "Britisher" than to most visitors. Our expresses are so good, and the distances they run so small, that even the journey from the Scilly Isles, by G.W.R. to London, and thence to Perth, and Inverness, and so across to Ströme Ferry and Portree—the longest trip I have made in our Islands—seems nothing in comparison.

Last night I was worried by a mosquito, and think I ought to mention it, because it is the only one I have seen whilst in America. It is now dead—of that I am certain—but it took much trouble to locate, spite of the persistence with which it sought a violent end. Perhaps it imagined that with a little more perseverance, the repeated blows which were intended for it, but which it avoided with such consummate skill, would prove fatal to *me*, either directly or through supervening exhaustion, and leave it complete master of the field and feast: the event, however, turned out otherwise.

To-day we have seen one or two "places" of the wealthy people of New York, and think them, and all the citizens, most fortunate in having such scenery within so short a distance. The gardens or parks (they are not exactly either) are beautifully kept by quite a host of gardeners, I should fancy ; and the blue and sparkling river, dotted over with the white sails of dainty yachts, sailing by ruddy cliffs and high banks of trees, forms a scene so bright and full of pure pleasure, that it must soon drive away all but the worst city cares. Yet I hear that, just at present, these delightful places of retirement and rest are taxed far beyond what seems reasonable to many people—even, perhaps, beyond the actual value of the land. If so, visitors may possibly enjoy the prospect more than the owners. I, for one, feel grateful for the permission to drive through, which I believe is generously extended to all alike.

The woods and fields are full of ferns and flowers, and the open view from the top of the hill is exquisite—one of the most restful combinations of river, wood, and gentle rounded hills imaginable, with low white houses and cottages peeping out along the winding shores. A deep veranda, with a large number of most comfortable chairs scattered about it, runs right round the old house ; and our last evening in the New World slipped by in silence, broken only by soothing country sounds—the faint chirrup of a sleepy bird, the muffled steps of lovers and their lasses, enjoying the delights of a moonlit ramble, free at last to exchange their one or thousand thoughts. Now a bat wheels its circles of noiseless flight

just by our heads ; or the thud of distant screw or paddle draws the eyes to where glimmering lights on mast and hull are passing on the dark water. Then all is hushed for a time, except for the leaves of the creepers, stirring in the cool night breeze, while the waning moon creeps up the sky. We must go indoors—and so good-night.

Not much more remains to be told. Eight o'clock next morning saw us in a heavily-laden "Surrey," carefully descending the hill. We reached New York in a train crowded with business men, and drove straight to the Ferry, and thence to the R.M.S. *Teutonic*.

Gliding down the wide estuary, we watched the dark Statue of Liberty. The profile, which I think might be much finer, gradually changes to full face as we steam slowly by, and, from this point of view, the figure is very grand, even inspiring. Perhaps the best wish one can frame for America, or for any other country, is, that it may find the true spirit of liberty dwelling with its people, whether they live under monarchy or democracy. History has often proved that the *form* of government matters little compared with its spirit. Whether America is freer from the bondage of money, party, and sin, than other nations are, must be a difficult matter to determine, even for those who know her and other nations well ; but, whatever be the truth, it was surely a noble thought that prompted the erection of this colossal witness to the professed ideal of the world, at what is the very entrance to the Western half of it for so many hundreds of thousands. And whilst she stands, a solemn

monument to the struggles of past years, with a grave welcome for the stranger, and a blessing for those who are leaving, she seems to bid all who pass to keep the torch burning, and, when their days of work are run, to hand on the sacred flame to others.

Before long we had left the statue far behind, and, with a bright blue sky and calm sea, the long, low coast gradually faded and vanished. Of the six days following but little need be said. Every one knows how comfortable a splendid boat like the *Teutonic* is. What was described as a "head sea" in the abstract of the log given to each of us on reaching Liverpool, we scarcely noticed. With pleasant company and congenial companions the time flew as fast as it ever does. We had two horned toads on board, brought by one of the passengers from Colorado. They were occasionally let loose on deck, and stirred up to take a little wholesome exercise. Once one of them made straight for a lady reclining in a deck chair, who did not exactly love toads, and disappeared under her skirts; to say that she took no steps to avoid, nor yet to displace, the little creature, is to reveal that it was not every one who enjoyed the homeward trip as much as we did. The Commander very kindly listened to some of my ideas about the Gulf Stream; but, though he agreed that much had yet to be done to unravel the North Atlantic currents, his own experience did not give me any positive support. He said that in the early summer he found evidence that the general Easterly drift was stronger than in the winter; but he did not

oppose my arguments from the tracks of the bottles, except to state that he thought it likely that prevalent winds had more to do with their directions than ocean-currents proper.

And so the story of our wanderings ends. Already it seems hard to believe that we, ourselves, picked up the gigantic fir cones, which somehow look bigger here than ever they did in their native woods ; and as we sit in cosy chairs before the flickering firelight at home and talk over our American experiences, we seem already to be recounting incidents in some dream, so altogether apart from our every-day scenes and events do they appear.

It was only on the return voyage that the chance word of a fellow-passenger made me think seriously of publishing this simple story : and if it should help Americans to know how much their grand country is appreciated ; still more, if by chance it should draw their attention to any points of beauty and interest they have not before noticed ; or if it kindles the wish in them, or in any one else, to see for themselves the wonders of the places we visited, and to write their own impressions, which must differ widely with different people and circumstances, the objects of the writer will be fully attained. And so he bids farewell.



APPENDIX I.

NOTE ON THE GULF STREAM.



THE following short paper is in the main the result of a systematic examination of the Chart, showing the paths taken by bottles thrown overboard in various positions in the North Atlantic, which is published, along with the monthly Pilot Charts, for the instruction and assistance of navigators, by the Hydrographic Office, Washington, D.C., under the auspices of Charles D. Sigsbee, Commander, U.S.N. . Should the results of further efforts to unravel the North Atlantic currents strengthen the theory which I venture here to put forward, my debt to the Government of the United States will be still further increased.

From the chart I saw, and of which the Captain of the *Etruria* kindly gave me a copy, I infer that the Gulf Stream is, to a certain extent, a *periodic* current. The reasons on which this conclusion is based are the following:—

(1) If two bottles are thrown into the sea near the Newfoundland Banks, one at the end of June—say when the ice is brought down by the Labrador currents to low latitudes, and the other—say in February—when the ice is frozen in up north, the first takes a due easterly and then southerly course, whilst the second goes in the direction of the Gulf Stream as generally drawn in atlases (Keith Johnston's *e.g.*), *i.e.*, in a north-easterly direction. Thus, by separating the bottles into

two groups—(a) thrown in between the beginning of April and the end of July ; and (b) between the end of November and the beginning of March—we obtain, as a rule, two very different pictures to represent the Gulf Stream, so far as longitudes east of the longitude of Newfoundland Bank is concerned. This is well borne out by the chart referred to, and furnishes the principal argument.

It is impossible, otherwise, to account for the way in which some of the paths of bottles cut others at quite large angles—unless the winds are the chief and direct causes of the motion of the waters, in which case the Gulf Stream, so far as our coasts are concerned, is not a true ocean-current, but a drift.

(2) The Gulf Stream being a *surface* current of warm water, if it meets with a large extent of floe ice and bergs, it must be either deflected, or part, with its heat in melting the ice, or carry the ice along with it. It cannot avoid the ice by flowing *beneath* it. That part which meets the ice must expend nearly all its heat in melting it, for every lb. of melting ice requires 1 lb. of water at 80° C. to melt it (and the Gulf Stream water is certainly not more than 25° C. at the point where it meets with the ice of the Labrador current), the 2 lbs. of water thus formed being at 0° C. Thus if this part of the current survives its impact with these ice remnants at all, its waters must be so cooled that they sink below the surface—the bottles show that they do not exist as a *surface* current running north-east—and, if they sink underneath, the additional friction must very greatly reduce the undercurrent's speed ; if, indeed, there is any speed left after threading through the ice : and, lastly, experience does not point to any great transfer of the ice by the Gulf Stream in a north-easterly direction.

The bottles seem to me to show that much of the current is deflected, so that it soon bends round to the south, and, joining the general westerly drift, circulates past the north shore of South America, and, hugging the shores of the Gulf of Mexico, rejoins the Gulf Stream at the extremity of Florida. The course of several bottles fully proves this ; and, if the times of their circulation be taken, indicates that they take about seven hundred days to perform the circuit, the very much larger value in one or two cases showing that they have made this circuit two or more times before getting into the Gulf Stream when it is unimpeded, and so finally being landed outside the limits of the recurrent path.

It will follow, too, that the time of year at which these circulating bottles pass through the Straits of Florida must settle in which direction they eventually go ; if it is about June or July they will circulate again, until they happen to return in the winter or spring when no ice is about, and then they will be carried north-west to the shores of Great Britain and Europe.

(3) The Captain (and he says he will answer for many others of his class agreeing with him) thinks that very much still remains to be done before men can say they understand the North Atlantic currents. In the *winter*, although the ice is fast up north, the Labrador current seems to be stronger than in the summer—judging from the increase in the length's run by the steamers when in the sphere of its influence. He does not think that the large icebergs and floes found south of the Banks can be the same year's ice, as there would not be enough time for it to come so far south between its melting (in April or May) and its being observed in *June*.

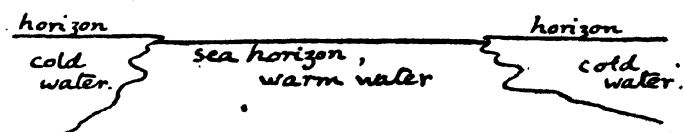
On the other hand, a Montreal leading man tells me that in June, or before, the way to the Atlantic is practically open for traders from that part of Canada—who often meet with very little ice, though always with *some*—and if it were not for this they would not at present be trying to open a road for ship traffic north of Newfoundland. Earlier than June, he says, the ships have to come south of Newfoundland by an almost land-locked channel.

A glance at the bottle-chart¹ will be sufficient to prove that though throughout the year the surface waters show an easterly drift, they cannot be said to move as they should, if the ordinary maps of the Gulf Stream represent facts. Take the paths of bottles like 61 and 34,² for example, cutting at an angle greater than 45° ; or see how the tracks cross each other south of Newfoundland, and at once it becomes clear that *even making the allowances for the errors inevitable to this kind of experiment*, something must cause the water in which the bottles are embedded (all but neck, and in some cases shoulders) to vary its direction through large angles. The first question to be answered is, what happens where the warm Gulf Stream and the ice brought down by the cold Labrador

¹ Reproduced on page 216.

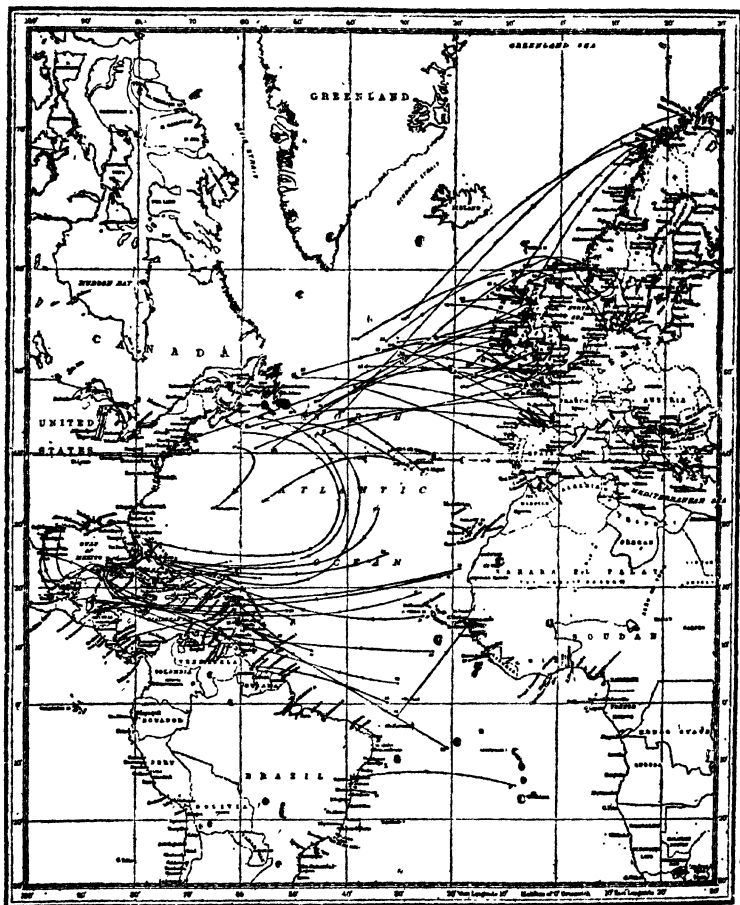
² The numbers refer to the number given to each bottle on the chart.

current meet? Warm water and ice being both specifically lighter than the cold sea water underneath them cannot avoid such a meeting; that they do so meet is abundantly proved by the fact that the ice floes and bergs are not carried further south by the cold current. Neither the ice nor the warm water can descend below the surface. If the Gulf Stream is strong enough to carry the whole body of ice with it, then it seems that the floes and bergs should be found further east than they occur; and *even if carried along in this way*, the effect of the large masses of ice in cooling the warm water of the current would be very marked from the length of time during which they are in contact. But the masses of floes and bergs are found to collect from the end of May to the beginning of August mainly in groups lying west of 42° W. long.; most, in fact, west of 48° W. long.; and their tendency is to drive in a southerly rather than north-easterly course. It seems scarcely possible that the Gulf Stream should *thread* these masses of floating ice; it would with less difficulty carry all along with it. It should be borne in mind that the ice is *continually* forced further south against the Gulf Stream by the powerful current from the north—it is a *sustained* conflict of the two *currents*—and although the Gulf Stream might be able to carry with it the ice floes, were they in still water to begin with, the result is at least likely to be very different when they are subject to a continuous acceleration—the very fact that the floes remain in about the same position, or drift very slowly south, would tend to prove that either the two streams were fairly matched on the ice arena, or that there the advantage is slightly in favour of the Labrador opponent. Further, the two currents do not merely slide past each other. Innumerable observations prove beyond doubt that each current is separated by the other where they meet, into long streams of alternately hot and cold water, the icy fingers of the North clasped in the warm grasp of the South. The fogs often follow these water stripes, and a very curious form of mirage sometimes results, in which the horizon appears shaped thus—



the depressed portions being over the warm streams, the elevated over the cold. Probably along with this point-blank contact there is also sliding contact. If so, the ice floes should be set rotating to the north of the Gulf Stream, in the cyclonic direction, *i.e.*, contrary to the hands of a clock. There seems but little direct evidence for or against such a rotation; if it exists at all, it is very slow. Thus it does not appear improbable that much of the warm water is so far entangled, or cooled in melting the ice, that it is no longer specifically lighter than the colder water below, and so, mingling with it, ceases to travel as an ocean current proper. For the rest of the Gulf Stream, there seems but one course open to it. Its direction has been deflected almost due east by the accumulated ice, level with, and south of the Banks; or if not exactly deflected, it is only the southern portion of the current, which has not met with ice, that survives to flow eastwards, and this has a far more easterly direction than the northern (due to the spreading of the hot water on the surface of the cold). Moreover there is no reason why any northern component of the Gulf Stream's motion should ever be replaced if it has once lost it, for (*a*) it must lie on the surface being warm water, hence the form of the ocean bed cannot affect it, and (*b*) the shore, which in the first part of its journey gave it a northerly impetus, is hundreds of miles further west; thus, once let it be deflected in a more southerly direction, it will remain so, flowing eastwards, growing thinner and cooler, till at last, joining water of its own specific gravity, it becomes lost in the Equatorial Drift westwards, or the south travelling African current. Thus so far as the Atlantic north of lat. 42° is concerned, whilst the ice is melting, there will be little or no true warm ocean current crossing it. Objects floating on the ocean waters will be left to take their direction from the prevalent winds, and these being at that time of year chiefly north-westerly, will give them paths more south-easterly than they would have followed had the Gulf Stream been present to contribute a north-easterly component to their motion. And so one is naturally led to suppose that if a group of bottles be thrown overboard at different seasons in about the same part of the ocean, we shall find that the mean direction of their course is more northerly, if they are set afloat at the time when all round the coasts of Newfoundland the ice is riveted to the mainland by the frosts of winter and spring; and more southerly, when the summer sun has thawed the bonds which held the ice in check, and set it free to float

southwards on the cold waters of the Labrador current. We shall expect some variation from variations in the weather of different years ; but since accumulated evidence shows that the liberated ice drifts are at their maximum in the part where they meet the Gulf Stream water in June and July, often



of considerable magnitude in May, and not altogether melted even by August, we shall expect the southerly routes to occur in this part of the year, the southerly tendency being less noticeable as a rule in late April and May, August and September, than in June and July. Conversely we shall expect

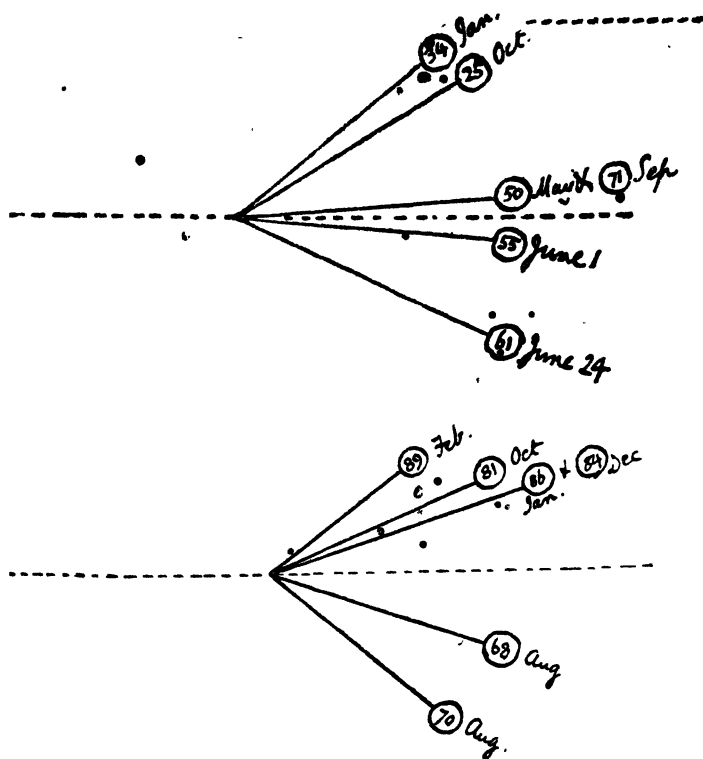
the most northerly paths in January and February and March, the coldest months of the year, and a distinct but gradual recovery from the summer's tracks already in progress from October or even September (by which month the ice is usually melted) as the ocean current little by little overcomes the inertia of the more slowly moving waters ahead, and once more establishes its north-easterly course. The table bears this out in the most striking way, as will be seen in the following selection from it.

EXAMPLE I, in which the paths are shown by arrows parallel to the apparent mean direction of path.

The dotted line parallel to the bottom of the page signifies a path whose mean direction lay east and west.

The numbers in the circles refer to the number of the bottles on the chart.

Group of bottles started close together in *Mid-Atlantic* about 51° N. lat., 30° W. long.



EXAMPLE 2.—Group started not very far from the west coast of Ireland, *i.e.*, lat. 50° N., long. about 20° W.

EXAMPLE 3.—Pair started off Newfoundland, 49° N. lat., 50° W. long.

No. 14, started in June, went south to Bordeaux.

No. 26, started in November, went north to Glasgow.

EXAMPLE 4.—Pair started S.E. of the Banks, 42° N. lat., 45° W. long.

No. 8, started in October, went south to West Indies.

No. 40, started in March, went north to Brest.

EXAMPLE 5.—Or take the four *southerly* courses of the four bottles which, starting from different places, landed in the Bay of Biscay. Arranged with the least southerly course first.

No. 3, May 21.

No. 14, July 24, 1895.

No. 62, July 25, 1896.

No. 61, June 24.

If this hypothesis of the variability of the Gulf Stream, so far as the Atlantic further east than the latitude of Newfoundland is concerned, is correct, the time of year when this ocean current should have its maximum *northerly* direction is in the late autumn, from the day when, after it has practically overcome all the ice, it has had time to re-establish its north-easterly circulation, to the day when the fresh ice, which by early spring has formed a wide solid peninsula jutting out far east and south of Newfoundland, extends far enough south to graze the Gulf Stream—this, so far as I can learn, happens in January or February—so that during March and April the northernmost waters of the Gulf Stream will then probably suffer *some* deflection or loss, in meeting with and melting the south-eastern limit of this vast floe. Thus, though the great mass of warm water will have a free path north-easterly across the ocean to our shores, even as late as the beginning of May, the tracks of bottles will not be likely to run quite so rapidly north as they do in late autumn and early winter.

From May, through the hottest months of our year, though an easterly drift undoubtedly continues, due to the direction of the prevalent westerly winds, I believe that there is little or no Gulf Stream proper, east of the latitude of the Banks and north of lat. 42° say; and if so, a fresh instance of wonderful economy is afforded, for the hot water is largely used in melting ice during the months when the climate of Western

Europe is warm enough without it, and is free to flow towards the Old World only when summer is waning, attaining its highest north-easterly velocity during the coldest part of our year, when without the remains of such a warm current, or the moist air blown from it, our ports in all probability would be fast bound with ice.

Appended is a list of all the bottles thrown overboard north of lat. 40° N., and west of long. 30° W., exclusive of Nos. 1, 7, 8, and 77, on account of the remarks made in the printed notes attached to the chart. They are arranged so that the first is that which took the most northerly mean course, the next less northerly, and so on, and the date of starting is attached to each.

No. 6, *May 21, 1893	A very slow drift, 2.9 miles per day.
No. 30, Nov. 26, 1895	
No. 33, Jan. 13, 1896	All went north.
No. 34, Jan. 25, 1896	
No. 36, Feb. 21, 1896	
No. 27, Nov. 3, 1895	
No. 39, March 11, 1896	
No. 26, Nov. 1, 1895	
No. 40, March 20, 1896	
No. 3, March 21, 1893	{ This was found in practically the same latitude as that in which it was set afloat.
No. 71, Sept. 5, 1896	
No. 50, May 8, 1896	All went south.
No. 62, June 25, 1896	
No. 55, June 1, 1896	
No. 14, June 24, 1895	
No. 61, June 24, 1896	
No. 72, Sept. 7, 1896	
No. 15, July 17, 1895	
No. 5, *March 26, 1894	

Though there are two—curiously the first and last—which do not conform to the hypothesis, and which are marked with an asterisk—to say nothing of the effect of storms—the track followed by No. 6 is rendered doubtful by its average drift being very slow, and No. 5 started rather to the east of the Gulf Stream's course as usually marked.

To sum up: Our present maps of the Gulf Stream are broadly untrue to nature, because they show the more

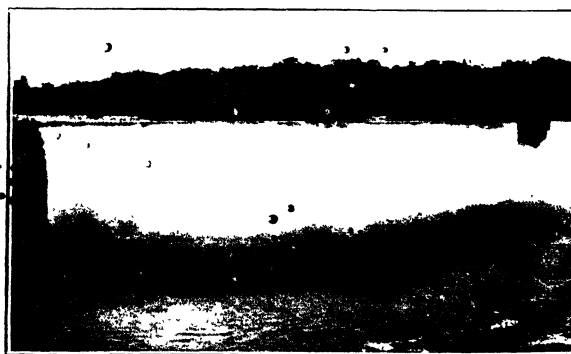
northerly and the more southerly courses of the Stream *as though they existed at the same time*; whereas the truth probably is that only *one* of them exists—the *Southern*—in June and July, whilst only the northern flows in January and February. In other months there will be more of one and less of the other, according to the nearness of the particular month to the seasons above mentioned, and the particular meteorological conditions of the year. Moreover the southern current at its strongest will not be so strong as the northern, since it is only that part of the Stream which has not met with the cold Labrador current and its ice; and this southern current falling in quickly with the trade winds is soon deflected westwards, and so prevented from warming the coasts of Africa at their hottest seasons.

The Gulf Stream, east of the Bank of Newfoundland, would thus appear to be *periodically variable* both in *direction* and in *volume*.

APPENDIX II

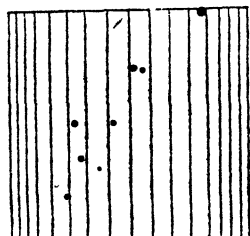
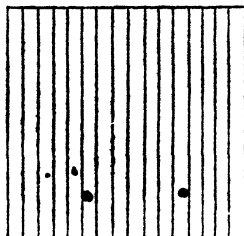
ON THE INCREASE IN THE APPARENT BREADTH OF THE AMERICAN FALL, DUE TO THE LINES OF FALLING FOAM

That the lines of falling foam cause an apparent increase in the breadth of the American Fall is proved, I think, by inspection of the two pictures of the Falls in the accompanying illustrations: one shaded by furrows, the other left plain; the plain one, to my eyes, appearing not so broad, and also a trifle higher than the other, though as a matter of fact it is the broader of the two. It is well known that of two equal straight lines, one divided into a number of equal parts by short lines, and the other left intact, the divided line always looks the longer; but the fact that stout people wear dresses striped vertically, and always avoid those striped across (*i.e.*, horizontally)—the effect of the former being to make them appear thinner or taller, or both, and that of the latter the reverse—this at first sight seems to imply that the Falls should look both higher and narrower from the effect of the foam furrows, which the illustrations show is not the case. The illusion produced in articles of dress is due, so far as I can see, to the lines narrowing together towards the sides,



owing to their being seen in perspective, and not only to the fact that the stripes are vertical.

Thus the square (a) with equidistant vertical lines looks a little broader than it is high, whilst the precisely equal square (b), shaded with the same number of lines so as to resemble the front view of a striped dress on a person, looks higher than



it is broad; and moreover, if the two squares be compared, the "perspective" square seems to have shorter horizontal edges than the other.

The effect is still more striking when the square, shaded so as to look cylindrical, has a greater number of lines as (c). In judging of the relative dimensions of the squares, the eyes should be as centrally as possible over *each in turn*.

APPENDIX III

MIRAGE

Mirage, a curious optical illusion, which is far more common on a small scale than most people imagine, depends upon two facts :—

1. That the place in which one sees an object depends upon the direction the rays from it take when they are entering the eye, and not on the path they pursued when leaving the object ; and

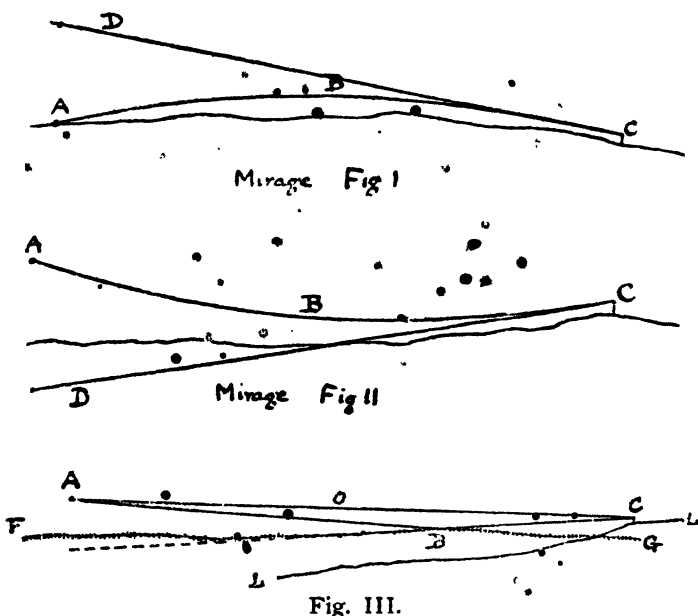
2. That rays of light only travel in *straight* lines under certain conditions, so that suppose A is an object (*vide* Fig. I.) reflecting or emitting a ray of light, A B C, which is curved downwards, entering the eye of an observer at C, the latter will not see A where it *really is*, but somewhere along the line, C D, which is the prolongation in a straight line of the part of the ray, A B C, just entering the eye at C. Now if, on a certain day, the air is much more dense (from cold, say) near the ground than it is higher up, the rays will actually be bent like this, so that all objects in the position of A will appear lifted up, and things may become visible which would, under ordinary circumstances, be hidden by the curve of the earth's surface, or are, as we generally say, "below the horizon."

On the other hand, if the sun has heated the surface of the ground so that the air near it is much hotter than that higher up ; or if it is the Gulf Stream which has heated the air over its warm waters with the same result ; the rays of light are curved upwards, as in the second figure, where A is supposed, for example, to be a particle of a white cloud, or of blue sky, sending a ray, A B C, which enters the eye of the observer, C, in the direction of C D. The result will be that C will see A, not at A, but at some point along C D—say D. The distance from C to D in both cases is, generally speaking, very nearly equal to C A, so that, as a rule, mirage does not make objects seem much nearer or more distant. A little thought will show that the nearer the eye is to the ground the more favourable is the position for seeing a mirage ; and often by stooping or lying down such effects may be seen when they are scarcely noticeable four or five feet above the ground.

There is another effect which is due, not to the refraction

or bending of the rays of light, as they traverse layers of air of different degrees of rarefaction or density, but to that curious and perfect *reflection* to which rays of light are sometimes subject if, in travelling through a medium, they fall obliquely on a surface separating it from a rarer stratum. This is best explained, perhaps, with the help of a figure.

Suppose A in Fig. III. is a point of a distant object—a mountain, say—one set of rays, A O C, travel straight in the colder air to the eye of an observer at C, and by these rays he sees the mountain at A where it *really is*; but another set of rays



from A, which would not ordinarily pass near him, are reflected at B, which lies on the surface, F B G, which separates the denser medium (cooler air) above from the rarer (warmer air) below; and these reflected rays, entering the observer's eye at C, in the direction B C, cause him to see the reflection of A at D. Thus if there is a line of mountains near A, these will appear as though reflected in the surface of this layer of warmer air, and the layer itself will perfectly simulate the appearance of water, the reflections following its every movement, just as they do the waves and ripples with which the surface of real water is troubled.

APPENDIX IV

SOME OBSERVATIONS OF TEMPERATURE MADE AT
THE BASE OF THE HORSE-SHOE FALL, NIAGARA

To Count Romford, and Dr. Joule, of Manchester, we owe the knowledge that the energy due to the motion gained by 1 lb. of water falling 777 feet, if all turned into heat, and applied to the 1 lb. of water, would heat it 1° Fahrenheit, or $\frac{5}{9}$ ths of a degree Centigrade.

Now the Canadian Falls are 162 feet high, and if the energy of motion gained by the water in its descent through this vertical distance were all turned to heat, and all the heat were used to heat the water, the river would be not quite $\frac{1}{8}$ th of a degree Centigrade warmer below the Fall than it is above it. As a matter of fact some of the energy is spent in pulverising the water, some in producing the sound of the Falls, so that the rise of temperature due to this cause could not be quite so great; moreover, heat is used up in evaporation, and the energy of motion is partly expended in overcoming the resistance of the air, and in setting it in motion to form the furious blasts of wind always blowing near the descending waters, so that the difference of temperature, taken as recorded, cannot possibly be accounted for in this way; and I am unable at present to offer any explanation of my observation except that possibly there may be some springs of warmer water along the base of the precipice over which the St. Lawrence falls, which, mixing with the newly fallen waters, raise their temperature. In the midst of so much fine mist one would suppose that there would be scarcely any evaporation from the liquid on the thermometer.¹ I can only repeat that my great surprise at the thermometer's readings made me verify them very carefully. The instrument placed in the torrent forming the stream was certainly more than a whole degree Centigrade colder than it was in the stream the torrent formed after falling. It was totally immersed in both, and gave the same results as before, when enclosed for some minutes wet in its narrow air-tight metal case. In the latter case evaporation could not, so far as I can see, possibly have affected it.

¹ It must be borne in mind that this is *not* a comparison of the temperature of the water above and below the Fall. All the readings were taken at the base of the cataract.

APPENDIX V

PHOTOGRAPHIC METHODS

So many photograph nowadays, that possibly a word or two on the methods which have enabled me to bring home my negatives and develop them all in England successfully may not be out of place. The plates used were Edwards' isochromatic medium and instantaneous. Where a good result depends upon the rendering in monochrome of the comparative brightness of colours, such as green, yellow, orange and red—which is very often the case in Yellowstone Park and in Colorado—yellow screens were employed. These cut off much blue light, and give time to the other colours to impress the plate. Of course the exposure is increased. For instantaneous views of Niagara and the Geysers, where it was desirable to catch the forms of rapidly moving masses of spray, the Thornton Pickard focal plane shutter is invaluable, and experience proves that exposures of $\frac{1}{500}$ th of a second, with a stop of $\frac{1}{8}$, are quite long enough to yield good pictures of these light-coloured subjects in the brilliant sunshine which is so continuously met with; and in scenes like the cañons and forests, and any, in fact, in which the look of distance is necessary to give any idea of real size, stereoscopic views are a great advantage, though the $3\frac{1}{4} \times 3\frac{1}{4}$ inch size of each picture is not an artistic shape. Some little time ago the author rediscovered a simple way of viewing them in stereoscopic relief on the screen as large as life. Seen thus, the effect is astonishingly realistic.

The safest way to carry glass plates seems to be to pack them *tightly* in pairs, film to film, with nothing between, and to wrap up the boxes in oilskin and tie them firmly round. Films present many obvious advantages, but the author holds that if the photographer be anxious to secure the very best results he must use glass plates properly backed. He is accustomed to enlarge his quarter-plate negatives to 25×21 inches, and, if considered desirable, can secure a picture as large as this sharp all over. He would like to add that a pale yellow screen is invaluable for taking panoramic views from mountain tops, especially if there be any haze, and is also use-

* The author has learnt that Sir Howard Grubb first discovered the method—which gives the effect of solidity by means of a rotating slotted disc.

ful in conjunction with an isochromatic plate for views deficient in contrast, also on cloudy days and after sunset, though not for the sunset sky (over the west) itself.

With the exception of a small book by Professor Piazzzi Smythe describing his experiences when camping in the Cañadas of Tenerife, the author believes this is the only book in which the illustrations have been published stereoscopically. He hopes the result may be sufficiently satisfactory to stimulate the interest taken in this charming branch of photography.

APPENDIX VI

GEYSERS—A NEW THEORY

Bunsen was the first to explain their action, and made it possible for Tyndall to construct a model which imitates, to some extent, a geyser. The temperature at which water boils depends mainly on the pressure to which it is subjected. Under ordinary circumstances this is always about fifteen pounds to the square inch, which is the force with which the air presses on it; consequently, we are accustomed to say that the boiling-point is 212° F., 80° R., or 100° C., according to the scale of the thermometer used. But if the pressure on the water is increased, the boiling-point is raised, *i.e.* the water must be heated to a higher temperature before it will boil; and if it be lowered, ebullition will occur at a lower temperature.

If a deep boring be made into the ground, and the temperature be taken at different depths, numerous experiments prove that for the first sixty feet, in ordinary circumstances, it is variable, depending on the season of the year; at about sixty feet the effect of the summer's heat and winter's cold is no longer felt, and the temperature is the same all the year round. Below this it rises, in England, 1° F. for every fifty feet you descend; but this amount varies in different countries, and the most rapid rise is recorded in volcanic districts, like that of Yellowstone Park, or Naples. But in no case has a more rapid rise been observed than that of 1° F. for every fifteen feet, or 1° C. for every twenty-seven feet (about). Imagine, then, a long column of water in a shaft which descends into the earth; the temperature of the water in the shaft will rise as its depth increases. If the liquid is free to circulate, since water expands, growing specifically

lighter as it is heated, the warmer water from below will be constantly rising next the hot walls of the tube, whilst the cooler waters from above will sink down the central line of the shaft in a convection current, which evidently tends to distribute the heat ; and if all the water were thus maintained at one temperature, if it boiled at all, it would only be near the surface, where the pressure is obviously least. But suppose that, for some reason (*e.g.* the friction which tends to stop the flow of water in a narrow tube, or a slant of the tube, which would greatly slacken the pace at which the water ascended as it would also slacken the rate at which the temperature rises), the water could not circulate sufficiently fast to distribute the heat equally, the temperature would gradually increase with the depth, until, if the liquid could scarcely move at all, it would not be very different from the temperature of the earth at the same depth. Now suppose this state of things is reached, and further, *that the temperature of the water at any depth is such that it is only the pressure of the liquid above it which keeps it from boiling*, then, if, as Bunsen supposes, a sudden generation of steam from below lifts the whole column of water up, making some of it overflow at the top, and so removing part of the pressure, every layer of water thus raised will burst into steam, and the expansion will throw the water, in the very act of boiling, out of the tube, causing an eruption such as one sees.

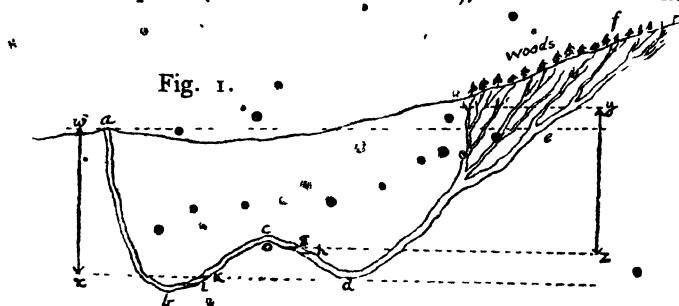
So far, all seems well explained ; it is only when one examines the theory and the geysers themselves carefully, that the great difficulties in accepting it in this form are seen. Others have suggested modifications of Bunsen's theory to account for the diverse behaviour of different geysers. These are briefly stated on page 166 of Captain Chittenden's very interesting book on the Yellowstone Park ; but the writer feels that there is a good deal more to be said, and hopes that what follows, if it does not seem conclusive, will at least stimulate fresh thought, observation, and, above all, experiment. He takes "Old Faithful" as the best known geyser, in order that what he has to say may be made more definite, and perhaps easier to understand. Actual measurements show that the average *out-pour* of this splendid fountain in a single eruption is *not less* than 1,500,000 gallons : *i.e.*, this quantity of water is poured out on to the terraces surrounding the crater, *and is not available for a second outburst*. As one gallon equals a little more than 277 cubic inches, this gives for the volume of water ejected, 240,450 cubic feet. Now this passes through the

geyser's mouth, which is six feet long by two feet wide (*i.e.*, twelve square feet in area), in four and a half minutes, or 270 seconds. Thus, its average velocity, or rate of flow, measured at the mouth of the geyser, during the four and a half minutes of eruption, must be $74\frac{1}{2}$ feet per second (about $50\frac{1}{2}$ miles an hour), and from this can be easily calculated the *mean height* to which the fountain should rise *if all its water were projected with equal force*; this turns out to be almost exactly eighty-six feet, which tallies well with observations.

Now "Old Faithful" rests sixty-five minutes between one eruption and the next, and it is not unreasonable to suppose that during that time the underground streams are accumulating the material for the next eruption; and to give a definite idea of what the total magnitude of the water supply must be, you have only to think of a stream six feet wide, two feet deep, flowing steadily all through the sixty-five minutes at the very considerable rate of a little over $5\frac{1}{10}$ feet per second. *Now the tube of the geyser is not left empty after the eruption, and this is a most important point*; the water, it is true, sinks a few feet in the crater, giving visitors a peep at the beautiful formation with which the tube is lined, but in a very few minutes it begins to rise slowly, *crawling up inch by inch*, till once again the crater is full, and that, too, with very hot water. If the underground river is flowing all through the period of rest, how do you explain the facts that (1) the tube is filled manifestly with new water directly after an eruption, and (2) then only rises a few inches in an hour? If it is steam from the bottom of the tube that lifts the water up and makes the eruption begin, why is the tube not emptied to its depths? and the same question may be asked without, so far as the author can see, a satisfactory answer from either Mackenzie's, Comstock's, or Baring Gould's theories. They all of them *either* empty the tube, which Nature does not do, *or fail to explain how* the supply of colder water is laid on in such a way as not to interfere with the super-heating of the water in the tube, necessary for the fulfilment of Bunsen's theory. It seems, in fact, impossible that the water supply should be acting to refill the tube, *except during the eruption itself*. Hence, if the stream be indeed continuous—and it is very difficult to imagine it is not so—it must be filling some cavity other than the tube during the quiescent period, and it is the water flowing from this second cavity into the tube which is the cause of the eruption of water, whether Bunsen's theory comes into play to make that eruption

explosive or not.¹ Since this flow nearly fills the tube afresh, during the eruption, the rate of flow of the water from this second cavity into the tube must be very nearly equal to the rate of flow of water from the geyser. Thus we are forced to the conclusion that in *Old Faithful's* case, and in all other cases in which the geyser tube is left almost full after an eruption, in spite of a great volume of water expelled, the eruption is that of an intermittent, deep-seated spring, its violent character being caused by the sudden boiling of super-heated water, carried by the cistern's overflow up the geyser tube to places where the pressure is not high enough to prevent the water from boiling. The hotter water, being lighter than the cooler, remains at the top, whilst the colder water, flowing in from below, raises it, forcing it upwards, as a piston would.

Suppose *a b c d e f* (Fig. 1) represents the geyser tube directly after an eruption (of *Old Faithful's* kind), and let us assume



- that equilibrium has been established by the fall of the water in the "outcrop" tube *d e f* to the level of the geyser's mouth *a*. If the rise of temperature with increase in depth below the earth's surface is fairly rapid, the water in the tube will be most rapidly heated at *b* and *d*, and the steam rising from *b* will rapidly heat all the water in the parts of the tube *a b*, *b c*. The temperature of the water in the tube between *d* and *e* will not be raised nearly so rapidly, because (1) the total cross-section of the tube or tubes which constitute this part of the geyser tube is probably greater than the corresponding cross-sections at any other part of the tube; and (2) because cold water is continually flowing into this part of the tube, and sinking to the lowest part *d*, or, at any rate, tending to do so, by virtue

¹ It is *most improbable* that the second cavity's filling or emptying should be accurately timed to the eruption from the tube, if the latter is caused by some action such as Bunsen's theory would indicate, which does not apply to the water in the second cavity.

of the fact that cold water is heavier than hot; and (3) because d may well be much higher than b . Thus after a time steam will collect in the upper part of the bend at c , whilst it will either be condensed in the longer column of water between b and a , or rising through the whole length of the column ba , will quietly escape through the boiling water, as indeed it may be seen to do in many instances to be found in the Park. Meanwhile the upper layers of the water in cd will have been raised by the steam rising in bc to the temperature of the steam itself; but the rest of the water in cd will not be nearly so hot, first because the cold water constantly flowing into cd prevents the formation of steam at d , if not entirely, at least to anything like the extent to which it is formed at b , and secondly, the very poor thermal conductivity of water would make the effect of the hot upper layer gh negligible, so far as its heating effect on the layers below it is concerned.

During this first part of the action we have, therefore, the steam formed in bc trapped at c , part of it condensed by the cooler water between c and d , a condensing action which will be continued for some time after steam has begun to collect at c , and which will make the level of the water between c and d higher than the level of the water between b and c — k in the figure. All this time fresh water has been flowing into the part of the tube fed, but by the well-known principles of Hydrostatics, the water and steam in the geyser tube will be in equilibrium, so long as the difference of level of the water in the tube's branches ab , bc , is equal to the difference of level of the water in the two branches cd , df , i.e., so long as wx (in the figure) is equal to yz (this obviously neglects the effect of the different relative densities of the water in the different branches of the tube: the correction to be made when this is considered is, that equilibrium will be maintained when the difference of level yz is rather less than wx). What happens next must depend on the conditions which obtain in each particular geyser; on the rate of inflow of fresh and cold water, on the dimensions and slope of the tubes, on the rate at which heat is communicated to their various parts, conditions which no doubt occur in endless variety; but whatever these may be, sooner or later there will come an explosive eruption, as the following considerations will make evident. Suppose that when the trapped steam ceases to condense in the part of the tube cd , the levels are those drawn in the figure, since the water between, at g , is practically at the temperature of the trapped

steam, it is evident that if a fresh portion of the water between b and k is turned into steam, the increased pressure in $k c g$ must tend to lower the level of the liquid on *both* sides of c , in reality a little of this fresh steam will condense at g since, unlike the water at k , the temperature of g has not been raised along with the pressure of the steam; and since the water has been taken from $b k$ to form the steam, and not from $g d$, and also because the water in $h d e$ is not so dense as that in $a b k$, the level at k will sink rather faster than at g , besides the fact that the growing head of water in $e f$ tends to maintain equilibrium under the growing steam pressure in the steam-trap, without making any change of level of the water at g necessary, and may in some cases actually do so. Thus the water-level in $b c$ sinks, whilst water either gently rises, or overflows at a , the difference of the pressure at a and k (wherever k may be) remaining the same as the difference of pressure between g and y (both g and y gradually changing).

Suppose that the level of k sinks to l , after this has happened any steam generated at b will escape at a (unless condensed on the way), and the level of the water in the geyser throat will sink as the water in the tube $a l$ boils away; but all the time the head of water in $f e d$ is increasing, and the cool water in $h d$ is creeping up towards c ; presently it reaches the top of the bend, and begins to overflow at o , slowly at first, perhaps with more or less violent ebullition, as it comes into contact with the sides of the tube between o and l , which have for some time been out of contact with liquid water, and may consequently have risen to a very high temperature. Such explosive generation of steam will cause violent pulsations in the water at the mouth of the geyser, and may well bring about Bunsen boiling, and a very rapid fall of pressure in $a b$ and therefore in $b c$, causing a full eruption of the geyser; but even if not, the ever accumulating waters in $e f$ will cause a continually increasing stream of cooler and cooler water to flow over at o till this cooler water either gradually or suddenly condenses the last steam in $c l$; for a moment, in the latter case, the water in the geyser throat may be pressed down the tube some distance by atmospheric pressure, but only momentarily; for the waters in $e f$ are no longer balanced, they drive the waters in $d c$ fast before them, liquid continuity is re-established throughout the tube, the contents of $a b$ are violently raised by the water piston, and an eruption occurs, not ending completely, till the state of things with which we

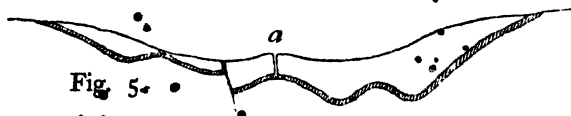
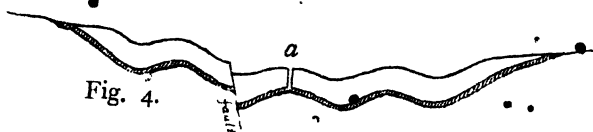
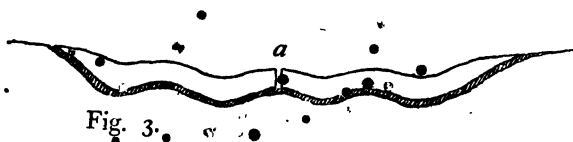
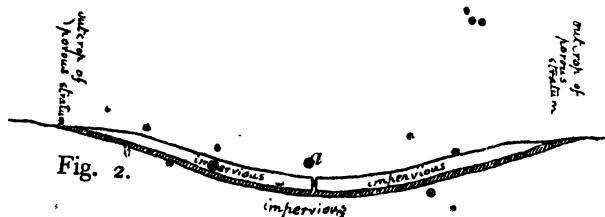
supposed the cycle of operations to begin has again come about, and the mouth of the geyser is left full of water once more.

If the beginning of the eruption of the geyser is to be looked upon as due to a sudden evolution of steam raising the water in $a b$, and so producing Bunsen boiling, we may explain the generation of this steam either as above, or thus: It is well known that if water is spilt upon a surface which is heated considerably above the boiling-point it does not burst into steam at once, but evaporates quietly, and that it is easier to perform this experiment with hot water than with cold. When, however, the temperature of the surface is lowered, and the cushion of steam which before separated the water from the hot surface is condensed, so that the water comes into actual contact with the surface—the latter being still very hot—a sudden burst of steam is the result, which may exert enormous pressure if the quantity of water and the extent of surface next it are considerable, and if the space in which the action occurs is closely confined.

To return to the diagram of the geyser tube: the first dribbles of hot water running over at o , on to the sides of the branch $c b$, possibly, intensely heated, might easily pass into this so-called "spheroidal" state, and this water might lodge on its way down to l in cavities and hollows in the lower surface of the tube; before long there must come a time when the temperature of the rock under these evaporating pools is reduced to a point when the supply of heat is insufficient to maintain the formation of the cushion of steam necessary to keep the hot water from coming into actual contact with the rock itself. Perhaps this may happen soon after the water begins to dribble over at o , perhaps not until the tube $b c$ is very nearly full of liquid, but whenever it does happen, if it happens at all, there will be a sudden explosive generation of steam, which will drive the waters violently down both $c b$ and $c d$; the head of water in $d f$ will doubtless be raised somewhat, but the steam will not in general be able to overcome the resistance in this direction, owing to the height of the out-crop, if not from its nature, which is almost certainly of a kind to resist any very sudden passage of water, though it allows fairly rapid percolation, and also the rapid passage of air. On the side $c b a$ the steam meets with a far less powerful resistance, and gives that upward lift to the waters in the branch $a b$ which is just what is required to bring about Bunsen boiling and an eruption; the head of water in $d f$,

increased by the explosion of the water in the spheroidal state into steam, reasserts its supremacy, the level of *g* rises rapidly to *c*, liquid continuity is set up afresh in the branches of the geyser tube, and finally the geyser throat is left full, or very nearly so, when the eruption is finished.

It will be seen that the level of the water in the outcrop tubes (on the right in Fig. 1) must be above *a* when the eruption begins, but since all the geysers have seen lie along the bottoms of valleys copiously supplied with water (in the



case of the Yellowstone Park by the thick woods with which the hills on both sides are covered), neither this, nor the quantity of water required, seem to be difficulties. The shape of the outcrop tubes, as drawn, is also of a kind likely to occur in the spaces between tipped up strata, which frequently follow the lines of a basin, giving rise under certain circumstances to artesian springs; and it seems far from unlikely that some of the boiling springs are in fact artesian wells of great depth, whose borings through the upper impervious soil (*vide* Fig. 2.) have been made by the expansive force of steam gene-

rated beneath from water which has filtered down from the hills between two layers of impervious soil, and there has been heated by the earth's internal fires till the tension became so great that, unable to find any natural vent, it burst a way through the hard roof of its long, shallow chamber, up which the heated waters rushed impetuously into the open air. In any case the silica, soluble in hot water only under great pressure, is deposited on the sides of the geyser pipe near the earth's surface, where the pressure is less, and probably for a hundred feet or more below, and this deposit prevents the waters from escaping laterally and from mixing with other waters in neighbouring outlets. Fig. 2 gives a section of the formation necessary for the artesian well, the permeable soil being shaded, and the impervious above and below it left blank. Now suppose that the subterranean forces produce local upheavals of the strata: we thus naturally pass to Fig. 3, where we see the same arrangement of soils, but waved in form, the exit pipe of the spring rising where there is least resistance, *i.e.*, from the highest point of the highest bend. From this to the arrangement sketched in Figs. 4 and 5 is an easy transition, needing only a "fault" to displace the strata vertically, but more over one part of the basin than the other, and in Figure 5 denudation has planed off the surface, the slight rise about *a* being in most cases due to the silica deposited by the geyser itself. It is clear that if the waved geyser tube does not pass through a region hot enough to cause the formation of steam, the curves would make no difference to the character of the spring at *a*, which would be an ordinary artesian of more or less hot water flowing constantly; but if steam is formed in the geyser tube we shall have the condition of things already discussed. Bunsen boiling may come into action, but there is no need for it; at any rate the eruption need not be started by Bunsen boiling, and so one great difficulty is removed, for in the case of "Old Faithful," if his tube be of the same cross-section throughout as it is at the crater (*i.e.*, 12 square feet), it must be no less than 15,200 feet long—a length nearly equal to the height of Mont Blanc; and if Bunsen's theory is to be applicable, the tube must be at all events so narrow that the water is not free to circulate. If, however, the explanation just given be correct, the tube need not be narrow, nor need it descend to any very great depth.

The difficulty of accepting Bunsen's theory as the complete

explanation of the action of the geysers is still further seen if we examine more carefully the rate at which the boiling-point of water rises when the pressure increases uniformly. This is shown graphically in the illustration, Fig. 6, by the curved line A B C D E, the points on which are found by plotting depths in feet along the horizontal, and the boiling-points of water at the corresponding depths along the vertical.

Thus the point C is on the curve, because *at 750 feet depth below the surface of the water in the geyser pipe* the temperature to which water must be raised to make it boil has been ascertained by experiment to be 217° . Singularly, D shows that at 1,000 feet depth the temperature must be 234° C., and so on. This diagram tacitly assumes (1) that the temperature of the earth at the surface of the ground is at the boiling-point of the water *there*—i.e., 92.12° C.—which is the most favourable supposition for Bunsen's theory possible; and (2) that the pressure increases directly as the depth, i.e., it neglects (a) the effect of the expansion of the water by heat, which would diminish its density, and (b) the compression of the water produced by the weight of the superincumbent water, which would increase its density, but not so much as the heat effect diminishes it. If corrections were made for (a) and (b), the effect might well be to make the curve a little flatter, i.e., at considerable depths the boiling-point of water would be a little lower than it would otherwise be. Now consider the straight lines on the same figure: that which cuts the curve at B is a line representing a temperature of 1° C. for every 5 feet of depth—a rise far greater than has ever been observed, even in volcanic districts; the next to the right stands for a rise of 1° C. in every 15 feet; and the next to the right again for 1° F. in every 15 feet (or 1° C. in every 27)—still a very rapid rise, but one which is still above the rates of rise met with in Nature. Now the first of these lines shows that down to a depth of about 500 feet the temperature necessary to make the water boil at any particular depth will be greater than the temperature of the earth at that depth; at 500 feet below the surface the temperature of the earth will just be able to make the water boil under the pressure at that depth; and every where below 500 feet the temperature of the earth will be above the temperature necessary to make the water boil, the difference between the two temperatures rapidly increasing with the depth; so that it is evident that *if there is little or no influx of colder water from beneath*, steam will be very rapidly

generated at depths below 500 feet, and the conditions will be favourable for an eruption of the Bunsen type, the cooler water in the upper part of the tube being expelled first, about one-fifth of it turning into steam, and then the more highly heated water from the lower part of the tube, a much greater proportion of which will become steam on emerging. So that the eruption will begin with a fountain of boiling water, and end, if the tube be deep, with a mixture of steam and water, of which the former may preponderate, and the tube will be left almost or quite empty, unless the ejected water is caught

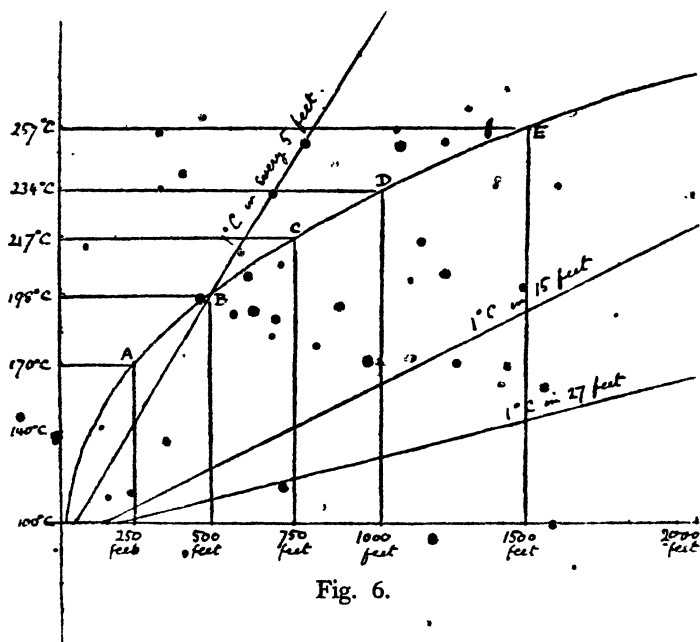


Fig. 6.

in a basin round the crater, and so flows back into the geyser's mouth as soon as the emission of steam which closes the eruption has sufficiently subsided to permit of its re-entrance. In this latter case the tube might be left (say) two-thirds full, or perhaps more. But there must be a supply of water to make up for what is wasted in steam, and the difficult point to settle is, how this enters so as not to interfere with the superheating. Once more one is driven to suppose that as the geyser tube fills up from below, the pressure of the accumulated water chokes off the supply; that a stationary period follows, during which the heating goes on, resulting in an

eruption of the Bunsen type. This may serve for the explanation of geysers like the "Minute Man," the "Economic," the "Vixen," and others; but the explanation totally fails where the quantity of water ejected is very great, and in spite of this the tube is left full, as in "Old Faithful's" case. *It must be carefully remembered, too, that the rise of 1° C. in 5 feet postulated is not to be considered at all likely to occur.* If we turn to a more probable rise, but still one which has never been verified, such as 1° C. in 27 feet,¹ the difficulty of accepting Bunsen's theory to account for even small geysers like the above seems *much greater*; for a glance at the illustration, Fig. 6, will show that the earth temperature line corresponding to this rise will not cut the water curve until the depth is at least 4,000 or 5,000 feet: so that *if there is no circulation of the water in the tube at all*, the temperature will not rise high enough anywhere in the first 5,000 feet for the water to boil; and we can hardly imagine that such toy fountains as the above-mentioned geysers are played from tubes of such a length as 5,000 feet, or even of 1,000, so that even these cases, which have been considered as the most perfect examples of Bunsen's theory, demand *(if that theory is to be maintained)* a rate of rise of temperature, far more rapid than any yet observed, if "the sudden generation of steam near the bottom of the tube" is to lift the heated column of water. If the tube is supposed wide enough to allow the circulation of the heated waters from below, the explanation might at first sight seem easier; for we can imagine masses of water (*not steam*) rising to places where the pressure might not be sufficient to keep them from bursting into steam, and that, too, with increasing energy, as all the water grows hotter until a sudden and explosive ebullition raises the water above, and a "Bunsen" eruption follows. But this demands free circulation for the water, for referring to the diagram again, and taking the rise of temperature as 1° C. in 15 feet (a *very* rapid rise, though perhaps not impossible in a region such as Yellowstone Park), we see that if the geyser tube was (say) 600 feet deep, the water at the bottom would be presumably at 132° C. Now suppose this water rose, by virtue of its being lighter, losing on its way (say) 10° C., in warming water it met with, it would be ready to burst into steam (at least about one-fifth of it would) at about fifty feet below the surface, which the boiling point curve shows is the depth at which water would boil at

¹ Judd gives 1° C. in 36 feet the maximum rate of rise yet found.

122° C. But it is evident that for masses of water to rise from 600 feet to 50 feet, *i.e.*, 550 feet, through cooler water (the water at 50 feet depth would be rather above 96° C., but of course could not be above 122° C.), and only cool by 10° C., demands almost free circulation for the water. In parting with some of its heat on its upward course, it would shrink, and so lose some of its buoyancy; but the most serious objection to this explanation is, that even if the temperature rises by as much as 1° C. in every 15 feet depth, the density of water must alter so very slowly from point to point that the currents started by this alteration must be *exceedingly* slow; and we are practically driven back to the conclusion that if Bunsen's theory is to apply at all, *steam* must be the agent which warms the water in the tube and lifts the super-heated column, and against this view we have already urged the two powerful objections of the great depth necessary for even the small geyser tubes (they would throw out much more water if their tubes were very long, or heated from a very great depth), and also the difficulty of assigning the time of supply, and the place where the supply enters the tube, so that it shall not interfere with the formation of steam. None of these difficulties remain if the "artesian spring" explanation suggested in this paper is accepted as correct. As before stated, the tube need not be narrow, it need not descend to any great depth. This theory also explains where the supply enters, the cause of the intermittency of eruption, and how it is that the geyser tube is left nearly full just after it has played. It allows ample time for the water to acquire its charge of siliceous matter, and moreover requires no special construction which is not already known to exist in nature in many places; it does not demand any special point for the application of the heat, the rise of temperature everywhere beneath the surface is sufficient. It supplies a key both to the large number of geysers and their different characters, and explains why the birth of a geyser should be attended with an eruption of such terrific violence as to shake the whole region; and it is adequate for the solution of such a problem as the Excelsior presents. Moreover the basin-like lie of the ground occupied by these splendid natural fountains, of which the very names of the districts are a constant reminder, is seen to be necessary for their existence.¹

¹ Read before the Physical Society of London, February 7, 1898.

APPENDIX VII

PHYSIOLOGICAL OBSERVATIONS

The following observations may interest physiologists. They were made with due care, on the summit of Pike's Peak, during the morning of September 7, 1897, by the author, on five men: A, B, C, D, and E.

Temperature of sleeping room at 8.15 a.m., minus 1° C.

	Temperature of body in degrees F.	Respirations per minute.	Pulse per minute.	Age of subject.	Remarks.
A.	98.4° F. (normal).	15 to 16	126 to 127	29	Has lived on the summit during the last 5 days.
B.	97.4° F.	26	88	Between 20 and 30	Has lived on the summit during the last 6 days. Has suffered from asthma.
C.	98.6° F.	14	78 to 79	33	Has lived on the summit during the last 7 days.
D.	97.8° F.	18	80	26	Has lived here 14 days, and "prefers the high altitude."
E.	97.1° F.	15	75	37	Has stayed here about 18 hours.

The temperature of the body was ascertained by keeping a small medical registering thermometer under the tongue for not less than four consecutive minutes, with the mouth shut. The pulse was taken at the wrist.

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• UNWIN BROTHERS,
• WOKING AND LONDON
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